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Elisha Mitchell Scientific Society

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ISSUED QUARTERLY

CHAPEL HILL, N. C., U. S. A.

ENTERED AT THE POSTOFFICE AS SECOND-CLASS MATTER

The Elisha Mitchell Scientific Society

JOHN GROVER BEARD, President.

J. M. BELL, Vice-President.

W. W. RANKIN, Secretary and Treasurer.

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JOURNAL
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Volume XXXIV SEPTEMBER, 1918 No. 3

PROCEEDINGS OF SEVENTEENTH ANNUAL MEETING OF THE NORTH CAROLINA ACADEMY OF SCIENCE HELD AT THE STATE NORMAL COLLEGE, GREENSBORO, APRIL 26 AND 27, 1918.

In the absence of President W. A. Withers (detained at home on account of sickness) and Vice-President J. H. Pratt (in France engaged in the great war), the Secretary, E. W. Gudger, called together the Executive Committee composed of himself *ex officio,* H. C. Beardslee, and Bert Cunningham. It was noted that another member of the committee, H. R. Totten, was also absent engaged in war service.

On motion, H. C. Beardslee was elected President *pro tem.* for the meeting. The Secretary reported that the membership list on January 1, 1917, contained 88 names; that 13 members were lost during the year due to removal from the State, resignation, or nonpayment of dues, and that 10 new members were elected; the membership on January 1, 1918, being 85.

The following new members were elected:

H. B. Arbuckle, Professor of Chemistry, Davidson College.

F. F. Bahnson, Ventilating Engineer, Winston-Salem.

Mrs. F. C. Bivins, Instructor in Science, Durham High School.

J. H. Coman, Instructor in Electrical Engineering, Trinity College.

C. C. Logan, Extension Agronomist, State Agricultural and Engineering College.

The Secretary-Treasurer next presented his financial report, found elsewhere, and it was afterwards referred to the Auditing Committe for report.

The invitation of Trinity College for the Academy to be the guest of the College at the next annual meeting was unanimously accepted.

Immediately after adjournment of the Executive Committee, President *pro tem.* Beardslee called the Academy to order at 2:45 p. m., and appointed the following committees: Auditing, F. A. Wolf, E. E. Randolph, and J. S. Holmes; Resolutions, E. Oscar Randolph, Bert Cunningham, and A. S. Wheeler; Nominations, J. J. Wolfe, W. C. Coker, and J. F. Lanneau.

The reading of papers was then begun and carried steadily forward until the Academy adjourned at 5 p. m.

At 8:15 p. m. the Academy reconvened in the physics lecture-room of McIver Building. Owing to the absence of President W. A. Withers, the presidential address, "Gossypol," had to be omitted. However, Professor W. C. Coker gave two papers with lantern-slide illustrations, "*Azalea atlantica* and variety" and "A Visit to Smith's Island." This island is of interest, since, situated at the mouth of the Cape Fear River, it is the northern limit of a number of interesting biological forms, the palmetto palm, for example.

The Academy then adjourned to the first floor of the Student's Building, where an informal reception was tendered the members of the Academy by the Faculty and the members of the Senior Class belonging to the Science and Home Economic Courses.

The Academy was called to order at 9:10 Saturday morning, and immediately went into annual business session. The minutes of the last meeting were read and approved. The Secretary-Treasurer then gave his report on membership, elsewhere noted. He next read his report of the financial condition of the Academy. This the auditing committee found correct, and it was ordered printed.

Report of E. W. Gudger, Treasurer, 1917-1918

RECEIPTS		EXPENDITURES	
Balance last audit	$ 179.86	Proceedings, 1917	$ 75.00
Dues since last audit	94.11	Printing	4.75
Interest savings bank acct.	5.31	Postage and telephone	4.19
		Clerical services	1.00
		Secretary's dues	1.00
		Secretary's expenses to Chapel Hill meeting	3.30
Total receipts	$ 279.28	Total expenditures	$ 89.24
Less expenses	89.24		
	$ 190.04		

RESOURCES		OUTSTANDING DEBTS	
Savings bank balance	$ 136.63	Proceedings, 1917	$ 75.00
Checking bank balance	53.41	Printing	4.00
		Miscellaneous (about)	3.00
Total	$ 190.04	Total (about)	$ 82.00
Dues unpaid (about)	$ 17.00		
Stamped envelopes (about)	3.50		
Estimated resources	$ 210.54		
Estimated debts	82.00		
Estimated balance	$ 128.54		

The Secretary then reported his inability to attend the Atlanta meeting last October of the Southeastern Association of Colleges and Secondary Schools, to which he had been appointed a representative of the Academy.

The Committee on Science Teaching in North Carolina High Schools next made a partial report, which, in connection with the papers read by E. W. Gudger at the preceding session, on the "Entrance Requirements in Science of the State Normal College," led to considerable profitable discussion. Finally the committee was reconstituted as follows: A. H. Patterson, H. B. Arbuckle, J. J. Wolfe, and S. J. Marion, continued until next year, and asked to bring in a full report.

The Nominating Committee next reported, and the following officers were elected for 1918-19:

President—E. W. Gudger, Professor of Biology, State Normal College.

Vice-President—H. B. Arbuckle, Professor of Chemistry, Davidson College.

Secretary-Treasurer—Bert Cunningham, Assistant in Biology, Trinity College.

Executive Committee (additional members)—Rev. George W. Lay, St. Mary's School; Miss Gertrude Mendenhall, State Normal College; Prof. J. J. Wolfe, Trinity College.

The Committee on Resolutions next reported, as follows:

Resolved, That we extend our heartiest sympathy to President W. A. Withers, who was prevented from attending this meeting by serious illness in his family.

That we extend our congratulations and best wishes to our members who have entered Government service.

That we pledge our support to the Government in all of its efforts to prosecute the war.

That we stand ready to aid our people in realizing and properly utilizing our peculiar economic and industrial advantages.

That we extend to the President, Faculty, and students of the State Normal College our sincere and united thanks for the kindness, courtesy, and cooperation shown us during our meeting here. And that we particularly wish to express our appreciation of the delightful reception given us on Friday evening, and of the equally pleasant entertainment at luncheon on Saturday.

At 9:45, after being welcomed to the College by President Foust of the Normal College, President *pro tem.* Beardslee presiding, the reading was begun of papers in the joint meeting of the Academy and the North Carolina Section of the American Chemical Society.

After the reading of chemical papers of general interest, at 10:30 the Chemists withdrew for their special meeting and the Academy took up its program.

At 12:50 both bodies adjourned and were entertained at luncheon by the College in the dining hall.

Reconvening at 2 p. m., the Academy finished its program and adjourned at 2:30.

The war conditions were clearly shown in the smaller number of papers on the program, and in the large number of members now in War service—10 out of an enrollment of 85—while others have gone to other States to engage in munitions and other war manufacturing. The attendance at the meeting was 24, and the considerable discussion of papers made possible by the smaller number of titles added much to the pleasure and profit of the sessions. Few more enthusiastic meetings have been held.

The membership of the Academy at the present time is 80. Those present at the meeting are marked *, and those in military service and carried as inactive members are marked *a*.

Andrews, T.
*Arbuckle, H. B.
*Bahnson, F. F.
*Balcomb, E. E.
*Balderston, Mark
*Beardslee, H. C.
Bell, J. M.
*Bivins, Mrs. F. C.
Bottum, Miss Frances
Brewer, C. E.
Brimley, C. S.
Brimley, H. H.
Bruner, S. C.
Cain, W.
Clapp, S. C.
*Cobb, Collier
Cobb, William B.
*Coker, W. C.
Collett, R. W.
Coman, J. H.
Cunningham, Bert
Detjen, L. R.
aDixon, L. F.
aDobbins, C. N.
Downing, J. S.
Edwards, C. W.
Farmer, C. M.
aFeild, R. H.
*Gudger, E. W.
aHarley, G. W.
Henderson, Archibald
*Hewlett, C. W.
Hickerson, T. F.
Hobbs, A. W.
Hoffman, S. W.
*Holmes, J. S.
Ives, J. D.
aJohnson, E. D.
Kilgore, B. W.
Lake, J. L.
*Lanneau, J. F.
*Lay, G. W.
Leiby, R. W.
Lewis, R. H.
Logan, C. C.
Lyon, Mary
aMarion, S. J.
*Mendenhall, Gertrude W.
Newman, C. L.
*Nowell, J. W.
*Patterson, A. H.
Pegram, W. H.
Pillsbury, J. P.
Poteat, W. L.
aPratt, J. H.
*Randolph, E. O.
Randolph, Mrs. E. O.
Randolph, E. E.
Rankin, W. S.
Riddick, W. C.
Roberts, G. A.
*Robinson, Mary

Sherman, Franklin
*Seymour, Mary F.
Shore, C. A.
Spencer, H.
*Strong, Cora
aTotten, H. R.
Venable, F. P.
*Wheeler, A. S.
Williams, L. F.
Wilson, H. V.
*Wilson, R. N.
Withers, W. A.
Winters, R. Y.
*Wolf, F. A.
*Wolfe, J. J.

The following papers were then presented:

Some Methods and Results of a Plankton Investigation of Chesapeake Bay. J. J. WOLFE AND BERT CUNNINGHAM.

The material was collected by the U. S. Ship *Fishhawk* at definite areas in the bay between October, 1915, and September, 1916. The methods of collection, preservation, volume determination, and counting were discussed. In determining the volume, the centrifuge was used on an original collection of 250 cc. Organisms in 25 cc. were counted.

The following conclusions were drawn: (1) There is little or no relation between the volume of the precipitate and the number of organisms. (2) Volume increases with depth. (3) Great variations in number of organisms occur in surface collections made on the same day, probably due to tidal influences. (4) The maximum of organisms is found at about 27 meters. (5) The optimum temperature lies between 46 degrees and 55 degrees. (6) The number of organisms increases greatly in two annual crests—spring and fall. This is not due to a general increase of all species, but to very great increase in one.

Further Occurrence of Cross-Conjugation in Spirogyra. BERT CUNNINGHAM.

The writer reports the occurrence of cross-conjugation in *S. weberi* Keutz. This supplements a previous report of the occurrence in *S. inflata.*

Notes on Buds. E. W. GUDGER.

Descriptions were given of the buds of the Sycamore, Smilax, and Sumac; all of which are found, not in the axil of the leaf, but under the base of the leaf, and hence, when the leaf has fallen, *in* the leaf scar. Attention was called to the compound flower buds of the Dogwood, Norway Maple, and Azalea, and to the complex-compound or mixed buds of the Sassafras and the Sweetgum. These buds being terminal buds of woody plants, would check the growth of plants were not some method devised by the plant to prevent this. The Dogwood and Norway Maple have two opposite buds below the flower bud which develop into branches. The Azalea has a cluster of lateral buds just beneath the big terminal flower bud, and these grow out into a well-marked whorl. The Sassafras has in the center of its large terminal bud a very small leaf-stem bud, while the Sweetgum keeps up its excurrent growth by a lateral bud which develops below the flower cone and forms a new branch.

Entrance Requirements in Science at the State Normal College. E. W. GUDGER.

The entrance requirements at the State's College for Women have recently been rewritten, and an attempt made to standardize them. They are now as uniform as the subjects permit for all the sciences accepted for entrance. Another purpose in working them over has been to write them in sufficient detail to give the teachers of high school science in North Carolina some standards to work to and some definite idea of the absolute amount of time required for a unit and the relative proportion of laboratory and recitation time. In the biological sciences, for the write-up of which the author is responsible, emphasis has been laid on the outdoor side of natural history, and a fair number of field trips in some cases will be substituted for laboratory work.

For all the sciences, emphasis has been laid on how well the subject has been taught and studied, and not on the quantity of space covered, on the formation of habits of observation and inference, of concentration and clear thinking.

The following papers appear elsewhere in this issue of the JOURNAL OF THE ELISHA MITCHELL SCIENTIFIC SOCIETY:

The Sun's Eclipse, June 8, 1918. Question. JOHN F. LANNEAU.
Extension of the Range of Prunus umbellata into North Carolina. J. S. HOLMES.
Eliminations from and Additions to the List of North Carolina Reptiles and Amphibians. C. S. BRIMLEY.
Herpetological Fauna of North Carolina Compared with that of Virginia. C. S. BRIMLEY.
Report of Investigations on the Cause of the Death of Matured Chicks in Shell in Artificial Incubation. H. B. ARBUCKLE.
A Visit to Smith Island (Lantern). W. C. COKER.

For the following papers no abstracts have been received:

The War Work of American Physicists. C. W. EDWARDS. (Read by the Secretary.)
Some Important but Largely Neglected Scientific Facts. GEORGE W. LAY.
Symptoms of Disease in Plants. F. A. WOLF.
Notes on the Magnetic Compass. T. F. HICKERSON.
Variations Within the Individual Sponge Towards Types of Structure Characteristic of Other Species and Genera. H. V. WILSON.
New or Interesting North Carolina Fungi. H. C. BEARDSLEE.
Mineral Fertilizers: Their Mode of Occurrence and Distribution in North Carolina. COLLIER COBB.
Recent Changes in Currituck Sound. COLLIER COBB.
The Return Stroke Due to Lightning. A. H. PATTERSON.
Azalea atlantica and variety. W. C. COKER.

E. W. GUDGER,
Secretary.

LUMINESCENCE OF ZIRCONS

By F. P. Venable

It has long been known that zircons from certain localities, as Norway and Expailly in France, phosphoresce when heated to low redness. Many of the zircons under this treatment become colorless and transparent, also in most cases the density is permanently increased. A number of investigations have been made into the cause and possible inter-relation of these phenomena.

Damour (Compt. Rand. **58**:154) has shown that there is slight and often inappreciable loss of weight in heating; that the index of refraction is changed as well as the density and that the increased density remains unchanged even when the heating is pushed to fusion (except in one or two of the cases examined). He suggests that it may be a matter of allotropism, the action of heat bringing about the change into the second allotropic modification. Fizeau (Compt. Reud. **66**: 1005) has shown that heat causes a lasting expansion of form.

The density of zircons varies from 4.0-4.74. This may be due in part at least to the presence of impurities driven off in the heating and to small variations in composition such as are revealed in the large number of published analyses. Zircons with a density under 4.7 may be raised to that density on heating. Those with a density of 4.7 show no material change.

The luminescence in question appears according to Henneberg (J. prakt. Chem. **38**: 508) at a temperature lower than that at which the color is lost or changed. The loss of weight may be from practically nothing to 0.45% and the change of density from 2.5% to 1%. The brown red color is lost at a temperature of about 300° C. Spezia (Ber. deutsch. chem. Ges. **10**: 295) has stated that according to his experiments the change of color is due to the reduction of the ferric compounds present, and that heating in a stream of oxygen restores the color. The experiments of Hermann (Z. Anorg. Chem. **60**: 369) were more detailed and exhaustive and he agrees with Spezia that the color is largely due to iron in different stages of oxidation and in the case of green zircon to an admixture with chromium.

Still Doelter (Monatsh. Chem. **31**: 319) concludes from his own investigations that Spezia is wrong in assuming that iron confers the color and believes that it is due to a colloidal substance of unknown nature. With regard to density he finds the green zircon to have the lowest and the colorless to have the highest (4.74). Green and yellow-green zircon, he thinks have a different coloring matter from brown and red (hyacinths). Stevanovic (Z. Kryst. **37**: 247) states that the bi-axial green zircon (D. 4.3) changes on heating into the uniaxial normal with a density of 4.7.

The varying accounts as to the properties and behavior of zircons may be in part explained by the somewhat wide variations in the composition of this mineral coming from different localities and the neglect on the part of earlier investigators to exclude the infiltrations of foreign matter which necessarily vitiate their results. Due precaution was exercised by Doelter and other recent workers to remove as far as possible such material as did not form a component part of the crystals.

Further light has been thrown on these changes in zircons by a study of their radio activity and the action of radium emanations upon them.

The radio-activity of zircons is markedly greater than that of any other hard mineral occurring in igneous rocks. Further, zircons contain hundreds of times more helium than the average rock of which they are constituent parts, and Strutt (Proc. Roy. Soc. A. **78**, 152: A. **83**, 298: A, **89**, 405) has made use of this fact as a means of determining the geologic age of the surrounding rock. This radio-activity is in excess of the uranium or thorium contents and indicates the presence of an accumulation of radium. The uranium-lead ratio has been determined by Holmes, the percentage of uranium found being 0.0019, and of lead 0.000085 (Proc. Roy. Soc. A. **85**, 248). Zircons show a greater radio-activity, also, than any other mineral associated with monazite.

The fact that the only mineral known to contain argon is the zircon mineral, malacone, has also aroused comment, but not enough investigation for complete confirmation (Kitchin and Masterson, Lond.

Chem. Soc. **89:** 1568). On heating, the mineral gives off both helium and argon. Twenty per cent of the helium is accounted for by the uranium present. Antropoff (Z. Elektrochem. **14:** 585) claims to have secured argon on heating native zirconia (baddeleyite) from Brazil. These observations should be most carefully tested by further investigations, as they open far-reaching theoretical questions.

This radio-activity of zircons has produced in the enclosing biotite, iolite, etc., the usual pleochroitic halos observed in connection with other radio-active minerals.

Strutt, as cited, makes use of the radio-activity of zircons for determining the age of geologic formations. Zircon crystals in plutonic rocks are opaque, those in basalt and lavas are transparent and show signs of incipient fusion. The transparent crystals are thermo-luminescent, giving out a phosphorescent glow and losing color when moderately heated. This property of thermo-luminescence has been noted in a number of minerals, as certain fluorites, etc. The glow is not repeated on a second heating if once heated until it disappears. Strutt found that it can be restored, and also the color, by exposure to the action of radium salts. This alternation can be repeated apparently indefinitely. Fluorspars act in the same way. Of course it is well known that the silicates in ordinary glass containers of radium compounds are deeply colored after sufficient exposure. Opaque zircons are not thermo-luminescent nor made so by exposure to radium. Nor are they decolorized by moderate heating. If kept in melted basalt for twenty-four hours they become white though not transparent, and then on exposure to radium emanations they acquire a red-brown color like the hyacinth and are thermo-luminescent. This treatment, however, does not make them transparent.

It is stated by Demarcay (Compt. Rend. **104:** 113) that zircons lose their color when heated in a stream of carbon tetrachloride. Only imperfect success was obtained on subjecting opaque zircons to this treatment. They were practically whitened and some small splinters seemed to be transparent.

CHAPEL HILL, N. C.

THE SUN'S ECLIPSE JUNE 8, 1918: QUESTION

By John F. Lanneau

Who in the shadow path on June 8th at the time of the total eclipse will look for

"A New Eclipse Phenomenon"?

When the total eclipse of the sun on May 28, 1900, was seen at Wake Forest, N. C., a surprising thing was noted.

My account of it was given in *Popular Astronomy* for February, 1901, in an article headed "A New Eclipse Phenomenon."

Quoting from that article:

> **A trivial addition to our outfit for the various observations made was a number of neatly prepared smoked glasses for naked-eye views of the progress of the eclipse.**
>
> **Each of these eye protectors consisted of a piece of clear glass, about six inches square, put over the smoked surface of a like piece of glass, the two held together securely by paper pasted along their edges. These simple glasses made an unexpected revelation.**
>
> **Soon after first contact, but more especially five or ten minutes before totality, when a smoked glass was held somewhat toward the sun, and tilting westward, there was seen on its nearer surface, as in a dull mirror, three fairly distinct bands extending horizontally across the glass. The bands were each about a quarter of an inch wide. The upper edge of each band was uneven or wavy. The lower part of each presented a ragged outline—a series of pendant tongues variously pointed and differing in length, breadth, and contour. Each band looked something like the familiar mirrored band of "manometric flames" produced by sound vibrations, only fainter, less regular, and also inverted, that is, the "tongues" downward.**

I so described the phenomenon in 1900. It was noted just before totality. But, diverted by the coronal splendors, no one looked for "reflection bands" just *after* totality. Had they been seen *then,* I think the "tongues" would have been, not pendent, but erect—pointing *up.*

In previous eclipses, for many years, there had been observed the well known, but unexplained, "shadow bands"—alternate dark and bright bands which just before and just after totality flit along the ground and across the south walls of buildings.

These often-seen shadow bands and the reflection bands first seen at Wake Forest in 1900, have doubtless a common origin.

Recall some well-known facts. The moon's surface is excessively rugged. On the side which is always turned towards us there are more than thirty-three thousand mountains. Part of the very rim of the moon is outlined by long mountain ranges. The moon's shadow cone, when it reaches the earth—as it must to make a total eclipse of the sun—is about two hundred and forty thousand miles long. It tapers from its base at the moon, two thousand miles across, to a width, where it meets the earth, of never more than one hundred and sixty-eight miles. Sometimes, at the earth, the shadow is less than one mile wide.

The observer of totality must be in the comparatively small shadow spot.

My *theory* is that both sets of bands, the familiar "shadow bands" and the newly observed "reflection bands" are caused by furrows of light in the surface of the shadow cone—furrows constantly lessening as they converge to the point of the cone—grooves of light broad and deep at the cone's base around the moon's mountain-peaked, serrated rim, but quite small where the shadow cone reaches the earth near its point.

The eclipse of 1900 was in the morning. Just before totality we were in the *under* surface of the shadow cone—the ridges of shadow, between adjacent light grooves, hanging or pointing *down*.

The eclipse of June 8th will occur in the afternoon. Just before totality the observer will be in the *upper* surface of the shadow cone—the ridges of shadow pointing *up*. He may therefore expect that "reflection bands" seen then will have, not pendent tongues, but tongues *pointing up*.

But facts are wanted. On the 8th of June, who in the long line of observers—from Southbend in Washington on the Pacific Coast to Orlando in Florida on the Atlantic—will get the facts?

Who of them will prepare in advance smoked glasses, and will look for "reflection bands" just before totality and just after totality? And who will have in readiness a kodak to picture the bands across his smoked glass?

WAKE FOREST, N. C.

ALTERNATION AND PARTHENOGENESIS IN PADINA*

By James J. Wolfe

The species with which these experiments were carried on is very abundant at Beaufort, and is reported as common on the coasts of Florida and the West Indies. Algologists have very generally referred it to *Padina durvillaei* Bory, but early in the course of this work the writer became convinced that this reference was incorrect. Specimens were then submitted to Dr. Farlow of the Harvard Cryptogamic Laboratory for his opinion in the matter. After his usual thorough examination, the details of which are reserved for a later paper dealing with the general morphology of the species, Dr. Farlow writes that he regards the form as *P. variegata* (Kg.) Vickers (8 & 9). Furthermore, Dr. W. D. Hoyt states that Mr. F. S. Collins, who has worked on his collection of Beaufort algae likewise refers this form to *P. variegata*. It is therefore reasonably safe to conclude that the common species of our eastern shores and the one upon which these experiments are based is *P. variegata* (Kg.) Vickers.

This plant presents the interesting condition seen in Dictyota and many red algae of three individuals in one life cycle—male, female, and tetrasporic. On casual inspection the three are quite similar, but under the microscope, even though their vegetative cells are alike, they can be readily distinguished by their reproductive structures, at least in the great majority of cases. With practice one acquires considerable skill in distinguishing them with the hand lens and even with the unaided eye.

In 1904 Williams (7), working with *Dictyota dichotoma,* presented very fully and completely the cytological evidence for the alternation of the asexual or sporophytic generation with the sexual or gametophytic. Hoyt in 1910 (1) published a brief account of his cultures from fertilized eggs and tetraspores of *D. dichotoma,* showing, as was expected from the cytological evidence previously brought out, that without exception the fertilized eggs produce tetrasporic

*Contribution from the Laboratory of the Bureau of Fisheries, Beaufort, N. C. This paper, in somewhat shortened form, was read before a joint session of the Botanical Society of America and the Botanical Section of the A. A. A. S. at their 1918 meeting in Pittsburg.

plants and that tetraspores invariably produce male and female plants. Since the present experiments were begun, Lewis (2) has published the results of similar experiments upon several species of Rhodophyeeae; his findings without exception confirming the theory of alternation.

Perhaps it may not be out of place in passing to point out that these plants, together with the one now under discussion, furnish teaching material peculiarly valuable in presenting the theory of antithetic alternation of generations by reason of the fact that the sporophyte is an entirely separate and distinct individual plant of equal size and the same general appearance as the gametophytes.

During the summer of 1910, while engaged at the Bureau of Fisheries' laboratory at Beaufort, N. C., in working on the morphology and cytology of Padina, it occurred to the writer that it would be well to duplicate Hoyt's work on Dictyota with this species. Furthermore, as it had been noticed that unfertilized eggs in laboratory cultures produce sporelings indistinguishable from those produced by tetraspores and fertilized eggs, and, as algologists (4) were uncertain as to whether or not fertilization was absolutely necessary in certain of the Dictyotaceae, it was determined to include unfertilized eggs in these experiments.

To grow spores to maturity at the laboratory being impossible, the method devised by Hoyt (1) was resorted to. Cultures were started in aquaria on oyster shells which were later transferred to various places in the harbor. The material to be used in these cultures when brought to the laboratory was sorted with the compound microscope, males being put into one aquarium, females into another, and tetrasporic plants into a third. They were kept thus under running water for variable periods of time before the experiments were begun. This was a precaution against transferring antherozoids in the experiments with unfertilized eggs, since, although there is a certain periodicity in the production of eggs and sperms and, as far as possible, material was therefore collected on the day preceding maturity of sexual elements, there are sometimes two or even three crops of antheridia on a plant at the same time. So far as sperms are concerned this precaution proved unnecessary, but very long periods of time (several days)

were of value in overcoming another serious difficulty—namely, the fact that fertilized eggs remain attached to the parent plant for many hours and perhaps days. This will be referred to later.

Selected individuals were then transferred to aquaria of sea-water which had been filtered in order to remove any chance reproductive bodies. Oyster shells previously scrubbed and dried were placed in the aquaria beneath the plants. Upon these the eggs and spores settled in great abundance and immediately germinated. This was found to be true of the eggs whether males had been put in with the females or not—a clear case, it would seem, of parthenogenetic germination. In every case there was a liberal growth of young plants before the shells were transferred to the sea. The cultures were kept in the laboratory for different periods of time, varying from four to twenty-four days, occasionally changing the filtered water upon them. Laboratory conditions within the above given time limits seemed to have had no adverse effect upon them except that growth was less rapid than when they were in natural surroundings.

Incidentally, measurements of length were made when these cultures were studied. The greatest length attained by any of the plants is given in a separate column in most of the tables. By comparison of the date on which the experiment was begun with the date of collection an approximate idea of the rate of growth may be gotten. In the first 50 days the best plants reach about 40 mm. in length, thus attaining something less than an average of a millimeter a day. In the next 30 days they frequently increase to 100 mm., thus averaging about 2 mm. per day. Approximate measurements made on selected plants growing normally on the rocks confirm this result.

A total of 63 such cultures were prepared and planted during this summer, 22 derived from tetrasporic plants, 22 from males and females, and 19 from female plants alone. In order to avoid contamination from chance spores these cultures were generally planted in regions at some distance from those in which Padina grew normally. Unfortunately, as was subsequently found, the conditions of growth are exacting, and consequently but few cultures matured their plants, and these in but small numbers. For the sake of brevity, and in view

of the fact that much fuller data were secured in subsequent years, a detailed report covering these cultures is omitted, as well as for the summer of 1911, in which the experiments were again begun, but terminated before completion except in very small part by the writer's unavoidable withdrawal from the laboratory.

TETRASPORES

During the summer of 1912 the experiments were again duplicated. For testing the product of tetrasporic plants, 4 series of 4 shells each were prepared in the manner above described. The cultures were planted between the 29th of July and the 9th of August. Since it had been found, as above mentioned, that little or no growth occurred except in places where Padina naturally thrived, cultures were planted in such localities exclusively. The shells were secured at different distances below the low-tide level to iron pipes driven into the sand. This was done with copper wire passed through holes drilled in the shells and pipes. As but little growth had occurred by the time it was necessary for the writer to leave the laboratory, a return trip to collect them was made September 25th. They were taken to Durham, N. C., in alcohol. By means of holes drilled in the shells and notches filed on the edges every culture could be identified with absolute certainty. Every plant from these cultures was examined with the compound microscope in order to determine with positiveness the kind of reproductive body borne upon it.

Of the 16 cultures covered with sporelings when planted, 5 showed no growth, 4 were not recovered, while the other 7 gave varying degrees of success. Table No. 1 gives the results and in part the conditions of the experiment all tabulated in detail. The total result is 154 males, 134 females, no tetrasporic, 2 doubtful, and 239 sterile individuals of small size. The doubtful plants are so classified because they have but few reproductive elements and these so young that it could not certainly be told whether they were female or tetrasporic. It should be stated, perhaps, that female and tetrasporic plants are, when young, often very similar in appearance, and in many cases even when mature can be distinguished with certainty only by measure-

ment. When mature the diameter of the tetraspore mother-cell is nearly twice that of the egg.

The relatively small number of plants which reached maturity in these cultures as compared with the much greater numbers secured in subsequent repetitions is believed to be due to lack of proper illumination resulting from the fact that the shells were so attached to their supports as to present their edges to the incident rays of light. Consequently, relatively few plants were favorably situated as regards sunlight. Especially is this worthy of consideration when one recalls that rays of light are refracted towards the normal on passing from air into water. Probably, also, some cultures were located on the north sides of their supports, and hence received no direct rays at all, as this detail had not then occurred to the writer. These ideas together with the further probability that the optimum depth which also appears to lie within narrow limits was not in all cases secured would, it would seem, account for the fact that no plants matured on 5 of the 16 shells, all of which were covered with sporelings when planted.

From the above seven successful cultures, however, it may be stated with certainty that tetraspores produce only sexual plants, since there were no tetrasporic individuals whatever produced.

Attention should, perhaps, also be called to the fact that each of these successful cultures was derived from a single tetrasporic plant, and that in every case both males and females were produced and in approximately equal numbers with the exception of culture 3b, which gave only 2 mature plants and these females. The small number in this and the other cases, it is believed, sufficiently accounts for the slight disparities. Comparison with the results obtained in 1914 and 1915, shown in Tables 4 and 8, where the numbers are larger, adds probability to this conclusion. These results indicate that sex is predetermined, probably when the spores are formed, and that one-half the spores bear the determiner for maleness and the other half for femaleness. This conclusion is rendered more probable when we recall that the spores producing male and female plants in equal numbers were derived from a single tetrasporic plant and grew upon

the same shell. It is difficult to think that the conditions here could be sufficiently different to have a determining effect upon sex. The view above expressed is of course in line with modern views of sex determination.

There remains to be discussed, perhaps, the fact that in Tables 4 and 8, which give the results of tetraspore cultures made in 1914 and 1915 respectively, tetrasporic plants occur—2 in 1914 and 20 in 1915. By reason of their location, now to be discussed, the chances for contamination by fertilized eggs floating to and settling upon the shells after they had been planted, were greater in 1914 than in 1912, and still greater in 1915. Since, as has already been pointed out, cultures were unsuccessful except where Padina normally occurred, it was absolutely necessary to locate them in the vicinity of other plants. In 1912 (Table 1) the shells were placed with their surfaces perpendicular to the surface of the water, which of course made the likelihood of chance spores lodging upon them very slight indeed, even though an abundance of plants bearing spores was nearby.

In 1914 (Table 4) the shells were attached to flat stones. The stones were then sunk some distance away from plants but in the general region of Padina growth and in such position that the surfaces of the shells bearing the cultures were parallel to the surface of the water. The better illumination would probably account for the greater number of plants reaching maturity per culture than in the former case. In 1915 (Table 8) the cultures were attached to stones as before and then placed in among growing Padina, merely removing the plants touching the cultures and those immediately around, their abundance rendering it impracticable to do more on account of the physical labor involved. The chances of contamination being thus vastly greater, it is not surprising to find a larger number of intruders. The facts above recited sufficiently explain, it is believed, the absence of tetrasporic individuals in 1912, the presence of 2 in 1914, and 20 in 1915.

Perhaps it should be added here that these experiments were attempted also in 1913, but the supports to which they were attached were undermined and washed away by a severe storm which swept the

southeastern Atlantic coast on the evening of September 2, 1913. Only a few cultures were recovered and these somewhat mutilated. As they show nothing that is not shown in the more complete series, a report here is not deemed worth while.

Considering now only those cultures which were successful and omitting such as failed entirely because such failure was in all probability due to the conditions of the experiment, the results from Tables 1, 4, and 8 may be summarized as follows:

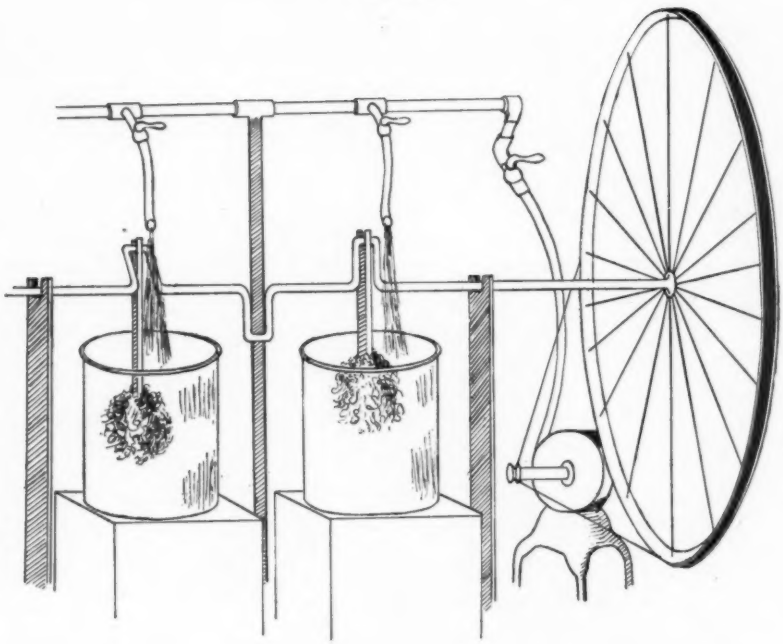
Date	Number of Successful Cultures	♂	♀	⊕	Average Number of Plants Per Shell
1912	7	154	134	0	41+
1914	8	242	257	2	62+
1915	8	426	379	20	103+
Totals	23	822	770	22	
Average per culture		35+	33+	0.9+	70+
Percentage of error				.01+	

The writer thinks that the tetrasporic plants already discussed can now safely be disregarded, and that there is nothing in the entire series which in any way weakens the statement based upon the 1912 cultures—that tetraspores produce only male and female plants, and these in equal numbers, even when the spores are from a single parent plant, as well as the seemingly necessary deduction that sex is predetermined, probably in the reduction division of the tetraspore mother cell.

FERTILIZED EGGS

The experiments to test the product of fertilized eggs as first devised were baffling in the extreme (see Tables 2 and 5). These tables are labeled "Cultures derived from Male and Female Plants" because it is believed, as will appear in the discussion to follow, that little or no fertilization occurred. The shells and plants were treated as in the experiments with tetrasporic plants. Four series of 4 shells each were carried through in 1912. For each series one male and one

PLATE 1



EXPERIMENTAL APPARATUS

female plant were put in each aquarium except series 5, in which several males and females were used. Of the 16 cultures thus obtained from male and female plants placed together in the same aquarium, which it was for a while supposed certainly insured fertilization, 5 only exhibited a tolerable growth. Fourteen of these plants are females, 2 males, 14 tetrasporic, 3 doubtful, and 97 sterile. We should expect only tetrasporic individuals, and we should expect also much larger numbers, comparable to some extent with those secured when tetrasporic plants were used as the source of the cultures. The results are not markedly different from those obtained when female plants without males were used as the source of the spores (Table 3).

The experiment was duplicated again in 1914 (Table 5) with essentially the same result, except that a greater proportion of cultures were successful and the number of plants per culture was somewhat larger. Since the opportunity for foreign spores to settle upon the cultures was somewhat greater by reason of the fact that the shells were attached in the immediate vicinity of fruiting plants, with their surfaces in the horizontal instead of the perpendicular, it is now safe to conclude, especially in the light of the following experiment, that most of these plants were derived from chance reproductive bodies settling upon the shells rather than the supposedly fertilized eggs which were germinating upon them when planted. It had previously been supposed that sperms would be freely discharged in the quiet water of aquaria as are the eggs and tetraspores. An examination, however, of the water in which male plants had been kept one night showed the presence of but few sperms. It was then concluded that the lacking factor for the discharge of sperms was probably the constant activity of the sea in localities where Padina grew successfully.

Accordingly, in the summer of 1915 two series of experiments were devised to test this idea. The plants, male and female, were tied to supports so attached to an axle that they were alternately forced down into the water and elevated a few inches above at each revolution (Plate 1).

The device was driven by a small water motor. In other respects the conditions were the same as in the experiments previously described. The results are shown in Table No. 11. From the 8 cultures 40 male, 33 female, and 776 tetrasporic plants were obtained. The 40 males and 33 females, representing a little more than 8% of the entire growth, are not too numerous, it is thought, to be accounted for as intruders, since the cultures were located in the midst of fruiting plants. This experiment, therefore, fairly conclusively demonstrates that only tetrasporic plants are produced by fertilized eggs.

PARTHENOGENESIS

As has been said above, it was noticed early in this work that unfertilized eggs germinated freely. It was assumed that these young plants would grow to maturity, but what they would produce was in doubt. From the uncertainty in the writings of algologists as to whether or not the sperms in the Dictyotaceae (4) are functional, it was of course permissable to expect tetrasporic plants. On the other hand, since it has been shown in the preceding experiments that tetraspores invariably produce males and females, and that fertilized eggs produce tetrasporic plants, as well as from analogy with other algae (7), it must be assumed that the chromosome number is reduced in spore formation and hence female plants and eggs must of necessity contain the haploid number. It is difficult to see how the diploid number characteristic of the tetrasporic plant (7) could be restored. The writer inclines to the view already expressed that the sex of the gametophytes is determined in the reduction division of the spore-mother-cell. Therefore it would be logical for germinating unfertilized eggs if they mature at all to produce female plants.

These alternative views will now be discussed in connection with the experiments. In 1912, 4 series of 4 shells each (see Table 3) were carried through. Although they were all covered with germinating eggs when planted, only 3 gave mature plants when collected. The cultures derived from female plants without males were strung on the same wire with those from tetrasporic plants as well as with those from both male and female plants, all on the same support.

Since 7 cultures of tetraspores were successful, whereas only 3 from unfertilized eggs gave mature plants, the conditions being identical, it must be assumed that the failure to produce mature plants on the part of at least 4 cultures of unfertilized eggs can only be explained by assuming that they were incapable of doing so. The few plants which were produced are probably due to chance spores falling into depressions on the shells, even though they were placed on edge, except perhaps some of the tetrasporic individuals—these latter to be referred to later.

In 1914 and 1915 control experiments were carried through in order to see the relation between the plants produced by spores which simply chanced to fall from Padina in the vicinity of the cultures. These controls were simply cleaned oyster shells, without reproductive elements of any kind upon them, attached alongside and therefore exposed to the same conditions as those bearing sporelings. The results are given in Tables 7 and 10. It will be noticed that male plants are most numerous, females less so, and tetrasporic least of all. It might be assumed that they should be equally numerous, as they are apparently so in nature. An examination of the various cultures will show that females are larger before beginning to fruit than males, and that tetrasporic plants are usually still larger, generally, than either males or females. Table 11, for example, shows but 2 females fruiting below 20 millimeters in length, whereas 6 males of this size are thus found. This relation, however, is not evident in all cases, and in particular cultures it is even sometimes reversed, but a careful calculation based on a large number of individuals bears it out. In Table 8, for instance, there are only 66 females fruiting below, to 313 above, 20 mm. in size. If the ratio for males, 89 to 337, should have been maintained, we should have had 83 instead of 66. In all the tables relatively few fruiting tetrasporic plants are found below 20 mm. in length. This difference in size at which the different plants produce reproductive bodies is believed to account for the slight preponderance in numbers of males over females, and both over tetrasporic individuals. In other words, there are among the young sterile individuals enough female and

tetrasporic plants, not sufficiently mature to produce reproductive bodies and hence indistinguishable, to bring their numbers to a parity with the males in the control cultures for 1914 and 1915. Examination of the various tables will show that sterile plants are all relatively small in size. During the entire course of these experiments very few were found as much as 30 mm. in length. This is true, however, only late in the season. When the plants first appear, late in June at Beaufort, they seem never to fruit until quite large, 60 to 100 mm. in length.

When the cultures from unfertilized eggs (Tables 3, 6, and 9) are compared with the controls, the only noteworthy difference is the greater number of tetrasporic plants found. Compare the following summaries:

CONTROL CULTURES

Date	Number of Successful Cultures	♂	♀	⊕	Average Number of Plants Per Culture
1914	6	66	47	34	24+
1915	4	150	111	36	74+
Totals	10	216	158	70	
Average per culture		21+	15+	7	46+

UNFERTILIZED EGGS

Date	Number of Successful Cultures	♂	♀	⊕	Average Number of Plants Per Culture
1912	3	1	20	24	15
1914	19	100	142	166	26+
1915	8	142	93	244	59+
Totals	30	333	255	434	
Average per culture		11+	8+	14+	34+

Whence comes this excess of tetrasporic plants in the cultures from unfertilized eggs as compared with the controls. The writer thinks that they are unquestionably due to eggs which were fertilized pre-

viously to being shed. Table 6 would seem to show this. In this case the same individuals used in series 3 were also used as a source of eggs for series 9, 10, 11, and 13. In series 3, where the plants had been kept separate from males for only 6 hours, we get males 14, females 9, tetrasporic 30—that is, tetrasporic individuals are greatly in excess; whereas in series 9 we get males 59, females 61, tetrasporic 51. Here the female plants were separated from the males for 13 days. This gave sufficient time for the fertilized eggs attached to the source plants to drop off before the experiment was begun. So with series 10, where they had been kept 18 days. This procedure was rendered possible after it was discovered that plants kept in the laboratory, and well aerated by a method devised by Mast (5), would continue for several weeks to produce eggs, so that the same plants could be used as a source of eggs for quite a long time. Individual cultures even in this table and some subsequent ones show variations from this average which it is believed are sufficiently accounted for by their location in the vicinity of other plants.

Series 3 of Table 9 gives as a whole males 71, females 37, and tetrasporic 23, a result entirely in line with the control cultures, and is sufficient to show that unfertilized eggs are incapable of reproducing Padina in any one of its three forms, since the results produced are clearly comparable to those secured in the controls.

However, Series 6 of the same table gives males 71, females 56, and tetrasporic 221. The great excess of tetrasporic plants in every single culture of this series can be due only to previous fertilization. Since the plants were here kept separate only two hours, it is highly probable that a greater number of perviously fertilized eggs were still attached to the parent plants when the experiments were begun. As this difficulty has entered into so many of the experiments a brief test of it was made in 1916. Female plants after having been kept separate from males for 24 hours were allowed to discharge their spores in the usual manner. The plants were then attached to the device already referred to (text fig. 1) for the purpose of dislodging any fertilized eggs wihch might still be clinging to the parent plants. They were then moderately agitated for about one hour once or twice

each day for 5 or 6 days. By this time an entirely new crop of eggs had formed and were ready for discharge. They were collected upon slides and shells as before. The spores germinated abundantly in each case, but from the second lot none survived longer than two weeks, while there were a goodly number of sporelings 5 to 10 mm. long upon the first lot of shells when the experiment was discontinued about six weeks later. The latter are clearly fertilized eggs capable of growth into tetrasporic plants under normal conditions, while the former were unfertilized eggs which divided and formed a cell body consisting of as many as 50 cells in some cases, but all of which without exception eventually perished.

This rather remarkable power of the fertilized eggs to cling to the parent plants, probably within the oogonia, for such long periods proved a very confusing fact through all the experiments dealing with eggs.

Tables 2 and 5, giving the results when the cultures are obtained from male and female plants placed together in an aquarium in quiet water show essentially the same results as the unfertilized eggs and control cultures, except that the proportion of tetrasporic plants is a trifle greater than in either of the other cases, due in all probability to the occasional fertilization of eggs by the very few sperms liberated under these conditions. The plants found on these shells, then, with the exception of the excess of tetrasporic plants, are also the result of chance spores. The following summary may be compared with those given for unfertilized eggs and controls.

CULTURES DERIVED FROM ♂ AND ♀ PLANTS

Date	Number of Successful Cultures	♂	♀	⊕	Average Number of Plants Per Culture
1912	5	2	14	14	6
1914	7	60	55	100	30+
Totals	12	62	69	114	----------
Average per culture	----------	5+	5+	9+	20+

The term parthenogenesis as ordinarly understood implies the production of mature individuals from unfertilized eggs. For the purpose of clear thinking it would, therefore, seem to be necessary to separate the structures usually called eggs into two groups: (1) those in which there is the haploid number of chromosomes, (2) those in which the diploid number obtains. There is a considerable number of forms both in the animal and the plant kingdom in which a so-called parthenogenesis seems to be a more or less normal or natural process. But so far as the writer has been able to ascertain, even after diligent search, there is not a single clearly demonstrated case of natural parthenogenesis among these in which the parthenogenetic egg unmistakably presents the haploid or reduced number of chromosomes. In the case of the honey-bee the male is produced parthenogenetically from an egg apparently having the haploid number of chromosomes. However, maturation is here very abnormal. For example, no chromatin is thrown out of the egg in polar body formation, although it is separated from the female pronucleus. The fate of this chromatin is, furthermore, variously interpreted. With such evidence before us, it would seem that for the present at least we are warranted in refusing to consider this case as sufficiently well demonstrated to be counted an exception to the general statement made above. (See Hegner: "Germ Cell Cycle in Animals," p. 265.) In the cases, then, of so-called parthenogenesis the structures involved are not true eggs and therefore should perhaps receive a name which more accurately defines them. However, it is with eggs having the reduced number of chromosomes that artificial parthenogenesis concerns itself. Loeb and a number of other experimentalists have succeeded in initiating cell division in several different animal and plant (Overton (6)) eggs which presumably had the reduced number and were apparently incapable of dividing normally. The methods employed consist in subjecting these eggs to various mechanical and chemical treatments. They have thus been able to carry them from a few divisions to highly developed and apparently normal larvæ—in the case of the frog to a stage in which the tail had practically been absorbed and 2 to 4 legs developed. Loeb and Bancroft

(3, p. 275) report the presence of distinguishable reproductive organs. However, in no single case has any such parthenogenetically produced animal been brought to sexual maturity.

It is rather too complacently assumed that the production of such mature animals is merely dependent upon the difficulty of imitating conditions in nature. These remarks are not intended to detract from the real achievement of these experimentalists who have demonstrated various methods of stimulating an egg normally incapable of division into further growth. Undoubtedly much light has been thrown upon the physics and chemistry of cleavage; nevertheless, the present purpose is to point out clearly that, in so far as is now demonstrated, this, instead of being parthenogenesis in the usual sense, is rather the artificial inauguration of a series of divisions of variable length in cells (eggs) generally incapable of further division, which may result in the production of more or less highly developed monsters, but which, as the experiments now being described indicate, are utterly incapable of reaching maturity.

Padina would seem to be an unusually favorable plant in which to test the potentialities of eggs germinating parthenogenetically, since the three individuals included in the life cycle represent both the haploid and the diploid chromosome numbers, reasoning from the behavior of tetraspores and fertilized eggs, and from analogy with Dictyota. Since it is difficult to see how the diploid chromosome number of the sporophyte is to be secured without fusion with the sperm, it might be supposed that eggs germinating with the haploid number could at least duplicate the gametophyte. The experiments above described have, however, shown this, also, not to be the case. The assertion of parthenogenetic germination in *Padina,* then, is nothing more nor less than the statement that the eggs are capable of a series of cell divisions. It is a fact that the shells were well covered when planted with eggs in division ranging from 1 or 2 cells to apparently well developed young plants. These had all the appearance of normal sporelings, attaching themselves to the shell, putting out rhizoidal filaments, etc. Nevertheless, somewhere between this time and the collection of the cultures they certainly per-

ished. The test made in 1916, already referred to, corroborates the result of the cultures. The first lot of eggs from the female plants gave sporelings which continued to develop during the course of the experiment. These, as has been said, were manifestly fertilized eggs, which remain attached to the parent plants for a remarkably long time, since the next lot, obtained about one week later and after agitating the plants sufficiently to dislodge the retained eggs, began growing as before, but all disintegrated after dividing into cells varying in number from 2 to as many as 50 or more.

Now, although in Padina and the Dictyotaceae generally unfertilized eggs germinate, according to the writer's interpretation of the above described experiments, in *Padina* at any rate, such germinating eggs invariably perish before reaching maturity. Comparing this case with the many cases of artificial parthenogenesis, it is unlikely that there can be any real differences between such cell division when inaugurated naturally and when artificially induced. If the former fail to mature, it would seem quitely probable that the latter must likewise fail, and from the same inherent difficulties, and therefore before artificial parthenogenesis is accepted in the sense in which it is ordinarily understood, it will be necessary to rear mature individuals from eggs containing the reduced number of chromosomes.

SUMMARY

The results above given in detail may be very briefly summarized as follows:

(1) Tetraspores produce only male and female plants. The numbers are approximately equal even when the spores are from the same plant and grown on the same shell. Sex is therefore predetermined, probably, in the reduction division of the tetraspore-mother-cell.

(2) Eggs when fertilized produce tetrasporic plants only. There is thus an alternation of a sporophyte generation which is an entirely distinct individual, with the gametophytic generation consisting of two separate plants, the one bearing eggs the other sperms.

(3) Unfertilized eggs divide freely, producing a cell body of varying size, but which invariably fails to mature. There is thus in *Padina* parthenogenetic germination, but no parthenogenetic reproduction.

TRINITY COLLEGE,
DURHAM, N. C.

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TABLE No. 1

TETRASPORIC CULTURES, 1912

Series Number	Material Collected	Kept in Separate Dishes	Experiment Begun	Culture Planted	Source of Spores	Individual Culture	Date Col-	♂	♀	⊕	Sterile	Doubtful
III	5 P. M., 7-8-12	14 hours	7-19-12	7-29-12	1 ⊕	3a	9-25-12	27	6		26	2
						3b	9-25-12		2		10	
						3c	9-25-12	6	3			
						3d	9-25-12	Not recovered				
Totals								33	11			
VI	7-25-12	9 hours	7-25-12	8-1-12	Several ⊕'s	6a	9-25-12					
						6b	9-25-12					
						6c	9-25-12					
						6d	9-25-12	Not recovered				
Totals												
IX	7-28-12	7 hours	7-28-12	8-3-12	1 ⊕	9a	9-25-12	16	11		116	
						9b	9-25-12				28	
						9c	9-25-12					
						9d	9-25-12	Not recovered				
Totals								16	11			
XII	7-28-12	7 hours	7-28-12	8-9-12	1 ⊕	12a	9-25-12	94	97		54	
						12b	9-25-12	11	15		5	
						12c	9-25-12					
						12d	9-25-12	Not recovered				
Totals								105	112		59	
Grand totals								154	134	0		

TABLE No. 2

CULTURES DERIVED FROM ♂ AND ♀ PLANTS, 1912

Series Number	Material Collected	Kept in Separate Dishes	Experiment Begun	Culture Planted	Source of Spores	Individual Culture	Date Col-	♂	♀	⊕	Sterile	Doubtful
II	5 P. M., 7-18-12	14 hours	7-19-12	7-20-12	1 ♂ and 1 ♀	2a	9-25-12				3	
						2b	9-25-12		1	2		
						2c	9-25-12					
						2d	9-25-12					
Totals									1	2		
V	11 A. M., 7-25-12	9 hours	7-25-12	8-1-12	Several ♂'s and ♀'s	5a	9-25-12					
						5b	9-25-12					
						5c	9-25-12					
						5d	9-25-12					
Totals												
VIII	2 P. M., 7-28-12	7 hours	7-28-12	8-3-12	1 ♂ and 1 ♀	8a	9-25-12	2			6	
						8b	9-25-12					
						8c	9-25-12					
						8d	9-25-12					
Totals								2				
XI	2 P. M., 7-28-12	7 hours	7-28-12	8-9-12	1 ♂ and 1 ♀	11a	9-25-12		4	3	22	
						11b	9-25-12		9	9	66	3
						11c	9-25-12					
						11d	9-25-12					
Totals									13	12		
Grand totals								2	14	14		

TABLE No. 3

UNFERTILIZED EGG CULTURES, 1912

Series Number	Material Collected	Kept in Separate Dishes	Experiment Begun	Culture Planted	Source of Spores	Individual Culture	Date of Collection	♂	♀	⊕	Sterile	Doubtful
I	5 P. M., 7-18-12	14 hours	10 A. M., 7-19-12	7-29-12	Several ♀'s	1a	9-25-12					
						1b	9-25-12					
						1c	9-25-12					
						1d	9-25-12					
Totals												
IV	11 A.M., 7-25-12	9 hours	10:50 P.M., 7-25-12	8-1-12	Several ♀'s	4a	9-25-12		3	1	10	
						4b	9-25-12					
						4c	9-25-12					
						4d	9-25-12					
Totals									3	1		
VII	2 P. M., 7-25-12	7 hours	11 P. M., 7-28-12	8-3-12	1 ♀	7a	9-25-12					
						7b	9-25-12					
						7c	9-25-12					
						7d	9-25-12					
Totals												
X	2 P. M., 7-28-12	7 hours	11 P. M., 7-28-13	8-9-12	1 ♀	10a	9-25-12		9	5	117	
						10b	9-25-12	1	8	18	30	2
						10c	9-25-12					
						10d	9-25-12					
Totals								1	17	23		
Grand totals								1	20	24		

TABLE No. 4

TETRASPORE CULTURES, 1914

Series Number	Material Collected	Kept in Separate Dishes	Experiment Begun	Culture Planted	Source of Spores	Culture	Date of Collection	♂ Length 20+ mm.	♂ Length 15-20 mm.	♂ Length Total	♀ Length 20+ mm.	♀ Length 15-20 mm.	♀ Length Total	⊕ Length 20+ mm.	⊕ Length 15-20 mm.	⊕ Length Total	Sterile Length 20+ mm.	Sterile Length 15-20 mm.	♂ or ♀	♀ or ♂	♀ or ⊕	⊕ or ♀	Doubtful	Greatest Length Attained, mm.
I	12 M., 7-20-14	6 hrs.	10 P. M., 7-20-14	7-31-14	1 ⊕ Plant																			
Remarks	Good culture all over shell but left too long					1a	10-17-14	13	....	13	8	....	8	....	....	....	....	....	....	....	....	....	4	110
	Good culture covering shell					1b	9-19-14	49	32	81	62	17	79	....	....	....	....	42	....	....	....	....	5	60
	Shell covered by sand and culture nearly killed. Young all killed					1c	9-19-14	8	....	8	7	....	7	....	....	....	....	....	....	....	....	....	....	70
	Plants confined chiefly to one end and edge of shell					1d	9-20-14	12	18	30	6	8	14	2	....	2	3	22	....	....	14	....	3	40
	Totals							....	....	132	....	....	107	....	....	2	....	....	....	....	....	....	....	....
V	10 A. M., 7-31-14	20 hrs.	10 A. M., 8-1-14	8-6-14	1 ⊕ Plant																			
Remarks	Good culture covering shell					5a	10-17-14	11	....	11	11	....	11	....	....	....	....	....	....	....	....	....	6	90
	Little or no growth					5b	10-17-14	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
	Good growth					5c	9-18-14	41	45	86	50	45	95	....	....	....	....	25	....	....	....	....	....	40
	Culture covering shell					5d	9-19-14	60	85	145	60	91	151	....	....	....	....	....	....	....	....	....	....	40
	Totals							....	....	242	....	....	257	....	....	....	....	....	....	....	....	....	....	....
	Grand totals							....	....	374	....	....	364	....	....	2	....	....	....	....	....	....	....	....

TABLE No. 5

CULTURES DERIVED FROM ♂ AND ♀ PLANTS, 1914

Series Number	Material Collected	Kept in Separate Dishes	Experiment Begun	Culture Planted	Source of Spores	Individual Culture	Date of Collection	♂ Length			♀ Length			⊕ Length			Sterile Length			♂ or ♀	♀ or ♂	♀ or ♀	⊕ or ♀	⊕ or ♂	Doubtful	Greatest Length Attained, mm.
								20+ mm.	15-20 mm.	Total	20+ mm.	15-20 mm.	Total	20+ mm.	15-20 mm.	Total	20+ mm.	15-20 mm.	Total							
II	12 M., 7-20-14	6 hrs.	10 P. M., 7-20-14	7-31-14	Several ♀ and 1 ♂ Plants																					
Remarks	Shell well covered					2a	10-17-14	4	----	4	8	----	8	40	4	44	----	6	----	2	2	----	1	5	100
	Shell fairly well covered					2b	9-18-14	6	1	7	2	1	3	2	----	2	16	42	58	----	----	4	10	12	40
	Scant growth and small					2c	9-18-14	2	11	13	2	3	5	----	----	----	3	44	47	----	----	5	7	----	40
	Scant growth and small					2d	10-17-14	3	3	6	3	5	8	6	15	21	----	----	----	----	----	3	5	5	40
	Totals							----	----	30	----	----	24	----	----	67	----	----	----	----	----	----	----	----	----
VI	10 A. M., 7-31-14	20 hrs.	10 A. M., 8-1-14	8-6-14	1 ♀ and 1 ♂																					
Remarks	Somewhat scattered over shell					6a	10-17-14	6	----	6	1	----	1	18	1	19	5	2	7	----	----	----	1	12	70
						6b	9-19-14	3	8	11	6	5	11	7	----	7	2	34	36	----	----	----	----	4	35
	No growth					6c	10-17-14	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
	Scattered rather uniformly over shell					6d	9-20-14	3	10	13	6	13	19	6	1	7	----	----	----	----	----	----	----	----	----
	Totals							----	----	30	----	----	31	----	----	33	----	----	----	----	----	----	----	----	----
	Grand totals							----	----	60	----	----	55	----	----	100	----	----	----	----	----	----	----	----	----

TABLE No. 6

UNFERTILIZED EGG CULTURES, 1914

Series Number	Material Collected	Kept in Separate Dishes	Experiment Begun	Culture Planted	Source of Spores	Individual Culture	Date of Collection	♂ Length			♀ Length			⊕ Length			Sterile Length			♂ or ♀	♀ or ♂	♀ or ⊕	⊕ or ♀	Doubtful	Greatest Length Attained, mm.
								20+ mm.	15-20 mm.	Total	20+ mm.	15-20 mm.	Total	20+ mm.	15-20 mm.	Total	20+ mm.	15-20 mm.	Total						
III	12 M., 7-20-14	6 hrs.	10 P. M., 7-20-14	7-31-14	Several ♀ Plants																				
Remarks	Good growth over entire shell					3a	10-17-14	1	----	1	2	----	2	29	1	30	7	11	18	----	----	----	----	5	70
	Fair growth only					3b	9-18-14	1	8	9	1	4	5	----	----	----	----	51	51	----	----	3	2	10	35
	Scattered on edges of shell					3c	9-19-14	3	1	4	2	----	2	----	----	----	1	7	8	----	----	----	1	----	30
	No growth, culture sanded up					3d	9-19-14	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
	Totals							----	----	14	----	----	9	----	----	30	----	----	----	----	----	----	----	----	----
IX		13 days	8-3-14	8-6-14	Same as in III																				
Remarks	Shell well covered					9a	9-19-14	10	34	44	15	21	36	7	3	10	9	84	93	----	----	----	----	9	40
	Shell not well covered					9b	10-17-14	----	1	1	6	4	10	2	5	7	1	25	26	----	----	----	----	4	50
	Shell well covered					9c	10-17-14	5	1	6	9	1	10	32	2	34	1	21	22	2	----	----	5	14	90
	Shell not well covered					9d	9-18-14	1	7	8	1	4	5	1	42	----	----	----	----	----	----	4	1	6	30
	Totals							----	----	59	----	----	61	----	----	51	----	----	----	----	----	----	----	----	----

X		18 days	12 M., 8-9-14	8-11-14	*																								
Remarks	Plants confined chiefly to shell margins					10a	9-18-14	8	11	19	3	2	5	----	----	----	4	37	----	----	----	6	1	----	30
	Plants scattered					10b	9-19-14	3	18	21	4	4	8	----	----	----	2	93	----	----	----	7	3	----	30
	Plants scattered					10c	9-19-14	14	33	47	9	16	25	2	2	4	3	63	----	----	----	5	3	2	30
	Plants confined chiefly to one end of shell					10d	9-19-14	3	6	9	3	12	15	7	5	12	2	39	----	----	----	2	2	6	35
	Totals							----	----	96	----	----	53	----	----	16	----	----	----	----	----	----	----	----	----
XI		20 days	10 P. M., 8-11-14		†																								
Remarks	Plants confined largely to one side and end					11a	10-17-14	3	----	3	2	----	2	23	4	27	1	8	----	3	----	1	21	14	60
	Plants confined largely to one spot on shell					11b	9-20-14	----	----	----	----	----	----	----	----	----	----	16	----	----	----	2	1	----	20
	Shell not recovered					11c		----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
	Shell not recovered					11d		----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
	Totals							----	----	3	----	----	2	----	----	27	----	----	----	----	----	----	----	----	----
XIII		31 days	8-22-14	8-24-14	‡																								
Remarks	No growth					13a	10-17-14	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
	No growth					13b	10-17-14	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
	No growth					13c	10-17-14	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
	Shell not recovered					13d		----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
	Totals							----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----

*Same individuals as used in III and IX.
†Same individuals used in experiments III, IX and X.
‡Same individuals used in experiments III, IX, X and XI.

TABLE No. 6—CONTINUED

UNFERTILIZED EGG CULTURES, 1914

Series Number	Material Collected	Kept in Separate Dishes	Experiment Begun	Culture Planted	Source of Spores	Individual Culture	Date of Collection	♂ Length			♀ Length			⊕ Length			Sterile Length			♂ or ♀	♀ or ♂	♀ or ⊕	⊕ or ♀	Doubtful	Greatest Length Attained, mm.
								20+ mm.	15-20 mm.	Total	20+ mm.	15-20 mm.	Total	20+ mm.	15-20 mm.	Total	20+ mm.	15-20 mm.	Total						
VII	10 A. M., 7-31-14	20 hrs.	10 A. M., 8-1-14	8-6-14	1 ♀ Plant																				
Remarks	Good growth on entire shell					7a	10-17-14	9	1	10	10	----	10	18	1	19	2	5	7	1	----	----	----	10	90
	No growth					7b	10-17-14	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
	Scanty growth					7c	9-19-14	----	----	----	----	----	----	----	1	1	----	3	3	----	----	----	----	----	20
	Scanty growth					7d	9-20-14	----	4	4	1	----	1	3	32	35	----	----	----	----	----	----	----	1	30
	Totals							----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
XII.....		10 days	10 P. M., 8-11-14	8-17-14	**																				
Remarks	Fairly good growth, though somewhat scattered					12a	10-17-14	1	2	3	1	1	2	19	2	21	----	15	----	----	----	----	----	6	70
	21 plants 15-20 mm. long, all sterile					12b	9-20-14	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	20
	Shell not recovered					12c	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
	Shell not recovered					12d	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
	Totals							----	----	3	----	----	2	----	----	21	----	----	----	----	----	----	----	----	----

XIV ----		21 days	8-22-14	8-24-14	††																							
Remarks																												
	No growth					14a	10-17-14																					
	Fair growth, but small					14b	10-17-14	1			1		4	2	6	1			1	13	82		2				10	40
	No growth					14c	10-17-14																					
	Shell not recovered					14d																						
	Totals										1			6			1											
	Grand totals										190			142			166											

**Same individual used in experiment VII.
††Same individual used in experiments VII and XII.

TABLE No. 7

CONTROL CULTURES, 1914

Series Number	Culture Planted	Source of Spores	Individual Culture	Date of Collection	♂ Length			♀ Length			⊕ Length			Sterile Length			♂ or ♀	♀ or ♂	♀ or ⊕	⊕ or ♀	Doubtful	Greatest Length Attained, mm.
					20+ mm.	15-20 mm.	Total	20+ mm.	15-20 mm.	Total	20+ mm.	15-20 mm.	Total	20+ mm.	15-20 mm.	Total						
IV	7-31-14	Surrounding Plants																				
Remarks	Plants confined to end of shell		4a	9-18-14	4	20	24	4	18	22	1		1	1	21						1	40
	Shell uniformly covered		4b	10-17-14	12	1	13	7	2	9	9	1	10								7	100
	Younger plants were sanded up and killed		4c	9-19-14	8	6	14		4	4	2	1	3	4	25			1	5	6	6	40
			4d	9-19-14	4		4	1		1	1		1	1		1			1		3	40
	Totals						55			36			15									
VIII	8-6-15	Surrounding Plants																				
Remarks	Shell uniformly covered		8a	10-17-14	8	1	9	10		10	19		19	1	13				3	8	10	70
	Plants scattered over shell		8b	9-18-14		2	2		1	1				2	26				1		3	30
	Shell not recovered		8c																			
	No growth		8d	9-18-14																		
	Totals						11			11			19									

| XV | 8-24-14 | Surrounding Plants | | |

TABLE No. 8

TETRASPORE CULTURES, 1915

Series Number	Material Collected	Kept in Separate Dishes	Experiment Begun	Culture Planted	Source of Spores	Individual Culture	Date of Collection	♂ Length 20+ mm.	♂ Length 15-20 mm.	♂ Length Total	♀ Length 20+ mm.	♀ Length 15-20 mm.	♀ Length Total	⊕ Length 20+ mm.	⊕ Length 15-20 mm.	⊕ Length Total	Sterile Length 20+ mm.	Sterile Length 15-20 mm.	Sterile Length Total	♂ or ♁	♀ or ♁	⊕ or ♁	⊕ or ♀	Doubtful	Greatest Length Attained, mm.
I	10 A. M., 8-3-15	8 hrs.	10 P. M., 8-3-15	8-11-15	Several ⊕ Plants																				
Remarks: Good growth						Shell No. 1a	9-27-15	70	23	93	67	19	86	7	----	7	15	25	40	----	----	2	3	----	60
Good uniform growth						Shell No. 1b	9-27-15	70	28	98	45	17	62	----	----	----	5	20	25	----	----	----	----	----	50
Good growth						Shell No. 1c	9-27-15	60	15	75	55	9	64	3	----	3	12	25	37	----	----	----	----	----	50
Uniform growth, but small						Shell No. 1d	9-27-15	9	2	11	9	1	10	----	----	----	30	20	50	----	----	----	----	----	40
Totals								----	----	277	----	----	222	----	----	10	----	----	----	----	----	----	----	----	----
IV	10 A. M., 8-17-15	8 hrs.	10 P. M., 8-17-15	8-24-15	Several ⊕ Plants																				
Remarks: Shell well covered—large plants						Shell No. 4a	10-23-15	25	11	36	21	17	38	1	----	1	----	3	3	----	----	----	----	----	65
Large plants—one corner bare						Shell No. 4b	10-23-15	26	----	26	28	----	28	----	----	----	----	----	----	----	----	----	----	----	75
Vigorous growth—uniform						Shell No. 4c	10-23-15	25	10	35	35	3	38	5	2	7	1	5	6	----	----	----	1	----	60
Excellent—uniform growth						Shell No. 4d	10-23-15	52	----	52	53	----	53	2	----	2	2	----	2	----	----	----	----	----	60
Total								----	----	149	----	----	157	----	----	10	----	----	----	----	----	----	----	----	----
Grand totals								----	----	426	----	----	379	----	----	20	----	----	----	----	----	----	----	----	----

TABLE No. 9

UNFERTILIZED EGG CULTURES, 1915

Series Number	Material Collected	Kept in Separate Dishes	Experiment Begun	Culture Planted	Source of Spores	Individual Culture	Date of Collection	♂ Length			♀ Length			⊕ Length			Sterile Length			♂ or ♀	♀ or ♂	♂ or ⊕	⊕ or ♀	Doubtful	Greatest Length Attained, mm.
								20+ mm.	15-20 mm.	Total	20+ mm.	15-20 mm.	Total	20+ mm.	15-20 mm.	Total	20+ mm.	15-20 mm.	Total						
III	10 A. M., 8-3-15	8 hrs.	10 P. M., 8-3-15	8-11-15	Several ♀'s																				
Remarks	Shell well covered					Shell No. 3a	10-23-15	21	8	29	11	5	16	9	1	10	8	37	45	----	----	5	2	3	60
	Shell uniform—males well developed					Shell No. 3b	9-27-15	27	----	27	10	----	10	7	----	7	36	----	36	----	----	2	2	10	50
	Scattered growth					Shell No. 3c	9-27-15	7	7	14	6	5	11	5	1	6	1	20	21	----	----	----	----	----	55
	Scattered sparse growth					Shell No. 3d	9-27-15	1	----	1	----	----	----	----	----	----	5	19	24	----	----	----	----	3	30
	Totals							----	----	71	----	----	37	----	----	23	----	----	----	----	----	----	----	----	----
VI	10 A. M., 8-17-15	2 hrs.	10 P. M., 8-17-15	8-24-15	Several ♀'s																				
Remarks						Shell No. 6a	10-23-15	30	5	35	17	6	23	49	2	51	17	16	33	----	----	2	----	----	50
	Uniform growth					Shell No. 6b	10-23-15	11	3	14	11	2	13	62	13	75	5	20	25	----	----	----	----	----	65
	Medium growth, but uniform					Shell No. 6c	10-23-15	9	3	12	5	2	7	42	10	52	1	20	21	----	----	3	1	----	60
	Fairly uniform					Shell No. 6d	10-23-15	10	----	10	12	1	13	39	4	43	5	15	20	----	----	1	----	----	70
	Totals							----	----	71	----	----	56	----	----	221	----	----	----	----	----	----	----	----	----
	Grand totals							----	----	142	----	----	93	----	----	244	----	----	----	----	----	----	----	----	----

TABLE No. 10

CONTROL CULTURES, 1915

Series Number	Material Collected	Kept in Separate Dishes	Experiment Begun	Culture Planted	Source of Spores	Individual Culture	Date of Collection	♂			♀			⊕			Sterile			♂ or ♀	♀ or ♂	♀ or ⊕	⊕ or ♀	Doubtful	Greatest Length Attained, mm.
					Surrounding Plants			30+ mm.	15-20 mm.	Total	30+ mm.	15-20 mm.	Total	20+ mm.	15-20 mm.	Total	30+ mm.	15-20 mm.	Total						
VII						Shell No. 7a	10-23-15	45	10	55	30	22	52	3	----	3	5	10	15	----	----	----	2	----	60
						Shell No. 7b	10-23-15	44	----	44	16	----	16	23	----	23	13	----	13	----	----	5	28	----	50
						Shell No. 7c	10-23-15	----	----	----	----	----	----	----	----	----	----	14	14	----	----	5	----	----	15
						Shell No. 7d	10-23-15	30	21	51	15	28	43	6	4	10	----	5	5	----	----	----	1	----	60
Remarks: Scattered growth; Fairly uniform; Practically no growth; Shell well covered—plants older at one end						Totals		----	----	150	----	----	111	----	----	36	----	----	----	----	----	----	----	----

TABLE No. 11

FERTILIZED EGG CULTURES, 1915

Series Number	Material Collected	Kept in Separate Dishes	Experiment Begun	Culture Planted	Source of Spores	Individual Culture	Date of Collection	♂ Length			♀ Length			⊕ Length			Sterile Length			♂ or ♀	♀ or ♂	♀ or ⊕	⊕ or ♀	Doubtful	Greatest Length Attained, mm.
								20+ mm.	15-20 mm.	Total	20+ mm.	15-20 mm.	Total	20+ mm.	15-20 mm.	Total	20+ mm.	15-20 mm.	Total						
II	10 A. M., 8-3-15	8 hrs.	10 P. M., 8-3-15	8-11-15	Several ♂'s and ♀'s																				
Remarks	Fairly good growth—uniform					2a	9-28-15	7	1	8	2	----	2	59	8	67	21	42	63	----	----	----	----	----	45
	Shell well covered					2b	10-23-15	7	1	8	2	----	2	189	30	219	20	107	127	----	----	3	2	----	70
	Good uniform growth, but small					2c	9-27-15	1	----	1	1	----	1	4	----	4	40	45	85	----	----	----	----	----	40
	Good growth					2d	9-27-15	4	----	4	8	1	9	125	11	136	23	25	48	----	----	----	----	----	50
	Totals							----	----	21	----	----	14	----	----	426	----	----	----	----	----	----	----	----	----
V	10 A. M., 8-17-15	8 hrs.	10 P. M., 8-17-15	8-24-15	Several ♂'s and ♀'s																				
Remarks	Uniform over shell—fair cultures					5a	10-23-15	5	----	5	2	----	2	64	----	64	20	5	25	----	----	1	1	----	50
	Uniform—excellent growth					5b	10-23-15	5	1	6	6	----	6	80	12	92	7	20	27	----	----	----	1	----	50
	Uniform—good growth					5c	10-23-15	2	1	3	3	----	3	100	10	110	20	20	40	----	----	----	1	----	60
	Uniform—good culture—large plants					5d	10-23-15	3	2	5	7	1	8	75	9	84	----	12	12	----	----	----	----	----	70
	Totals							----	----	19	----	----	19	----	----	350	----	----	----	----	----	----	----	----	----
	Grand totals							----	----	40	----	----	33	----	----	776	----	----	----	----	----	----	----	----	----

THE AMERICAN PITCHER-PLANTS

By Roland M. Harper

The American pitcher-plants (family Sarraceniaceae), which are totally unlike any other plants in the Western Hemisphere, though distantly related to the Old World family Nepenthaceae, have long attracted popular attention on account of their carnivorous habits and striking appearance. The family comprises three genera, with nine known species, a few subspecies, varieties, or abnormal forms, and several hybrids; all perennial herbs, growing in damp sandy soils and boggy places in temperate climates. They have nearly all been cultivated for ornament in Europe, especially in Great Britain and Ireland, where several horticultural varieties and artificial hybrids have originated.

The leaves of all the species arise from subterranean rootstocks, and are normally tubular, with a longitudinal wing on the anterior side. This tube corresponds with the petiole of ordinary leaves, and is usually surmounted by an appendage known as the hood, varying greatly in shape in different species, which corresponds to the leaf-blade. So odd are the shapes of the leaves of some species that it is impossible to describe them adequately in words, and for this reason it has been difficult to interpret correctly some of the early descriptions that were unaccompanied by figures, and some confusion in nomenclature has resulted.

In some of the species the leaf-tubes are wide open to the sky, and in others the hood is curved over the mouth of the tube in such a way that no sunshine or rain can enter directly. In the latter case the convexity of the hood is always provided with numerous white translucent spots which serve to illuminate the interior, the advantage of which will appear presently. A red pigment (anthocyan) is quite characteristic of the family, appearing in varying degree in both leaves and flowers. It is generally best developed in plants growing in sunny places.

The leaves contain more or less liquid, which in the species with open tubes is mostly rain-water, but in the others is a secretion from

The author of the article on pitcher-plants failed to receive proof, and consequently several typographical errors were overlooked, and a few references in the text to illustrations that were not used were inadvertantly allowed to stand. The cut of *Sarracenia purpurea* (Plate 2) is from a photograph by Dr. George E. Nichols of Yale University, and should have been so credited.

the plant. Late in the summer the tubes are usually half filled with dead insects of many species, which have been lured thither by the bright colors of the hoods, or a sugary secretion on the outside of the tubes, or both. Just within the mouth of the tube the surface is so smooth that it affords a very insecure foothold, and a little farther down is a close array of stiff hairs pointing downward, which make descent very easy and ascent by crawling almost impossible. And the tube is usually too narrow for an insect of any size to fly out after it once gets inside. The function of the "windows" in the over-arching hoods is now evident, for flying insects as a rule do not like to enter dark places. Once within the zone of downward-pointing hairs, death by drowning is almost inevitable; and human ingenuity could hardly devise a better fly-trap than a pitcher-plant leaf.

There are, however, a few species of insects which in the course of ages have learned to circumvent these elaborate pitfalls and even to profit by the misfortune of their less wary fellow-creatures. In many of the leaves can be found one or more larvæ feeding on the carcasses, and these when the proper stage in their development arrives escape by gnawing their way out, or perhaps in some cases by flying. Occasionally a spider spins its web across the tube and robs the plant of some of its prey. Or when there is more water than insects mosquitoes may use these natural pitchers for breeding-places.

There has been some difference of opinion as to whether the pitcher-plants actually digest the insects entrapped in their leaves; and doubtless the digestive action is less easily demonstrated in some species than in others, and may take place only during a brief period of the year. But the conclusion is irresistible that such highly specialized contrivances must be of some advantage to the plant, and when the leaves finally decay the insect remains in them must contribute in no small degree to the nutrition of the plants through their roots, if nothing else.

The flowers of all the species are rather showy and more or less odorous, but last only two or three weeks, and only a minority of the plants in a given area seem to bloom in any one year. In the South American species there are several flowers on one stalk, but in the

the plant. Late in the summer the tubes are usually half filled with dead insects of many species, which have been lured thither by the bright colors of the hoods, or a sugary secretion on the outside of the tubes, or both. Just within the mouth of the tube the surface is so smooth that it affords a very insecure foothold, and a little farther down is a close array of stiff hairs pointing downward, which make descent very easy and ascent by crawling almost impossible. And the tube is usually too narrow for an insect of any size to fly out after it once gets inside. The function of the "windows" in the over-arching hoods is now evident, for flying insects as a rule do not like to enter dark places. Once within the zone of downward-pointing hairs, death by drowning is almost inevitable; and human ingenuity could hardly devise a better fly-trap than a pitcher-plant leaf.

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others there is only one flower to a plant. In *Sarracenia,* the largest genus, the flowers are borne on erect naked stalks (scapes), from less than a foot to over two feet tall. At blooming time, which ranges from March in Florida to August in Labrador, the top of the scape is bent over so that the flower hangs downward. After the petals and stamens fall the axis of the flower assumes a more or less horizontal position, and the sepals and pistil together with the great umbrella-like stigma turn green and remain without further change until late in the fall, when the seeds are ripe. Just how the seeds are transported from place to place is not known, but very likely become attached to the feet of migrating birds in some way, for some of the species have a wide and rather sporadic distribution.

One of the genera, *Heliamphora,* with a single species, is known only from Mt. Roraima in British Guiana, where it was discovered about 1838 by Sir Robert H. Schomburgk, a noted explorer, who surveyed the boundary between British Guiana and Venezuela, and also discovered the *Victoria regia,* the giant of the water-lily family. It grows in rather inaccessible places, but has been seen by a few subsequent explorers.

Another genus, *Darlingtonia* (more recently called *Chrysamphora* on account of a conflict in nomenclature), likewise with a single species, is confined to the mountains of Oregon and California. The remaining genus, *Sarracenia,* is confined to the southeastern United States between latitudes 28° and 36°, except that one species extends a little way into Virginia and another far into Canada, almost to the Arctic Circle. Like many other bog plants, they are most abundant in regions where most of the precipitation comes in the warmer half of the year and thus counterbalances the evaporation to a considerable extent. The flowers of the seven species of this genus are all much alike except in color (some being red and some yellow) and size, but the leaves are very diverse. Some of the species regularly, some occasionally, some never, produce in addition to the normal insect-catching leaves sword-like ones consisting of wing only, without tube or hood, or in some species there are all gradations between normal and tubeless leaves (phyllodia). The phyllodia are chiefly produced in cool

shady places, or in the fall to last through the winter, but what benefit they may be to the plant is not obvious. The normal leaves are perfectly evergreen in the species in which they lie close to the ground, and die down in the fall in the taller species; and there are various intermediate conditions.

The leaves of the southern species are called "pitchers," "bugles," "fly-catchers," "lilies," or "trumpet-flowers" by the natives, and the fruits, or spent flowers, which they perhaps do not always recognize as being a part of the same plant, are sometimes known as "ladies' watches," or simply watches. The northern species is sometimes called "side-saddle flower" or "huntsman's cup."

The hybrids are of course all in the genus *Sarracenia* (for the single species in the other two genera have no near relatives to hybridize with), and they grow wild only between the James and Mississippi rivers, for elsewhere no two species grow in proximity. For a small genus, whose representatives all grow in strictly natural habitats and shun civilization, the number of hybrids is remarkably large. Artificial hybrids were produced in European greenhouses more than forty years ago, before the existence of natural hybrids was definitely known, and now there are more such hybrids than there are species, not counting compound hybrids, of which there are several. Natural hybrids were first recognized about twenty-five years ago, and we now know at least five simple combinations and one probable compound.

It has been my good fortune to see in their natural surroundings all the North American species of this family and nearly all the known wild hybrids, and to take photographs of about half of them in the field. In the next few pages are brought together some notes on the history, habits, and distribution of these plants, including quite a number of facts and photographs not previously published. The distribution is given in some detail, for the benefit of readers who may wish to seek the plants in their native haunts.

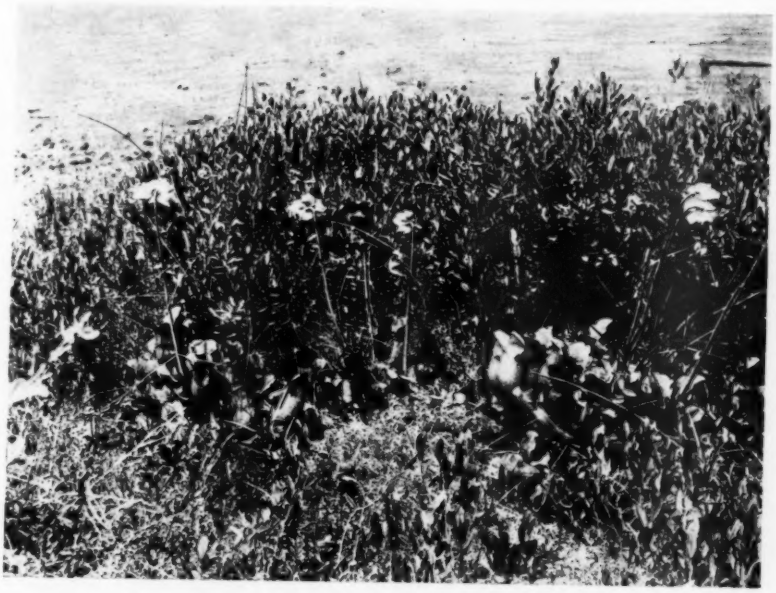
The western pitcher-plant, *Darlingtonia californica,* grows in mountain meadows in and near the Cascade Range, in southwestern Oregon and northern California, between the 39th and 44th parallels of latitude, and from near sea-level to 8,000 feet above. It was dis-

covered by J. D. Breckenridge, assistant botanist of the Wilkes exploring expedition, a few miles south of Mt. Shasta, in October, 1842; but the flowers, without which the plant could not be properly characterized, were not known until they were collected near the same place by Dr. G. W. Hulse in 1851. It was described and named by Dr. John Torrey of New York in 1853.

The leaves are reddish or yellow with translucent spots, usually less than a foot tall but sometimes over three feet, and twisted 180° so as to bring the opening under the arched hood to the outer side of the clump. An appendage resembling a fish-tail, a couple of inches long, which has no counterpart in the other members of the family, hangs in front of the orifice (which opens downward), and is more or less covered with nectar. Whatever liquid is in the leaves must be secreted by them, for rain cannot enter from above, and there is very little rain in that part of the country anyway, for most of the precipitation comes in winter in the form of snow. It is said to bloom from May to July. I was a little too late to see the flowers when I made a special visit to one of the southernmost known localities for it, in Plumas County, California, immediately after the A. A. A. S. meetings at Berkeley in 1915. The plants at that locality are so surrounded by grass and other vegetation that it is not easy to photograph them in their natural setting, but the accompanying illustration gives a good idea of the general appearance of small specimens without flowers.

The northern pitcher-plant, *Sarracenia purpurea,* is the most widely distributed species of the whole family, and naturally the best known (Pl. 2). Just when and where and by whom it was first discovered is not certainly known, but there is an unmistakable figure of it in Clusius's *Rariorum Plantarum Historia,* published in Amsterdam in 1601. The genus is named for Dr. Michel Sarrasin (or Sarrazin) of Quebec, who flourished a century later, and sent specimens of this plant among others to Tournefort, in Paris, who was one of the founders of systematic botany. The early herbalists who wrote about it thought it to be a near relative of *Limonium* (a genus including the common sea-lavender of our salt marshes, which indeed it does resem-

PLATE 2



SARRACENIA PURPUREA. Salisbury, Connecticut.

ble slightly in the position and texture of its leaves). The names *Bucanephyllon* and *Coilophyllum* had also been applied to it before Tournefort's time; but our nomenclature dates from Linnieus (1753), who adopted Tournefort's generic name for this plant.

It is fairly common in sphagnous bogs in the glaciated region from Newfoundland and the Northwest Territories to Wisconsin and northeastern Pennsylvania. South of the terminal moraine it is known in a few places in southern Pennsylvania and one station in Maryland (near Baltimore), and is fairly common in the pine barrens of New Jersey. Then there is a gap in its known range, and the remaining localities are south of Virginia and east of Mississippi River. It has indeed been reported in the past from Virginia, Kentucky, Tennessee, and Louisiana but without definite locality, and no botanist now living seems to have seen it in those States (or in West Virginia). Possibly some former stations for it may have been destroyed by drainage operations. In North Carolina it is found in many of the "pocosins" in the southeastern part of the State, as well as in a few places among the mountains; and in South Carolina it occurs sparingly both in the sand hills of Chesterfield County and in the flat pine-barrens in the southern part. In Georgia it has been found only three or four times, in Randolph, Lee, and Tattnall counties. (And in the last named I was unable to find it in 1915 in the same place where I had collected specimens in 1904, though the spot did not seem to have been tampered with in the interval.) In West Florida and southwestern Alabama, however, it is quite common in gently sloping wet pine-barrens, and does not differ perceptibly from the New England plant. Farther west it becomes scarcer again, and, as stated above, it is not now known to grow in Louisiana.

The leaves form a rosette, and as a rule lie half buried in moss, with the mouths of the pitchers wide open to the sky, so that they must be filled to overflowing by almost every shower. The hoods are paler than the tubes, but are more or less mottled and streaked with red. Variations occasionally found are yellowish leaves and flowers, and leaves with tube and hood almost wanting. The flowers are normally purplish red, and unfold from April to August accord-

ing to latitude. The leaves are perfectly evergreen, and must be capable of enduring freezing temperatures for several months at the northernmost stations.

Sarracenia psittacina, the smallest member of the genus, resembles the preceding in having the leaves widely spreading in a rosette, and in being very similarly colored. They are quite differently shaped, however, and usually smaller and more numerous than those of *S. purpurea.* The usual type of leaf, found in flat sandy pine-barrens, is short and prostrate, with a comparatively narrow wing, and of a prevailing reddish color except for the white "windows" in the hood. The other extreme of leaf-form, found chiefly in shaded sphagnous bogs, is obliquely ascending, with a broad wing, long tube—sometimes eight or ten inches long—and small hood, and much paler in color. In either case the plant hardly ever stands out above its neighbors sufficiently to be photographed satisfactorily, and it is scarcely visible until one is within a few yards of it. It differs from all its congeners, and resembles *Darlingtonia,* in having the entrance to the pitcher a small round opening on the inner side of the globose hood, which bears little resemblance to any ordinary leaf-blade. The leaves, although of rather thin texture, are evergreen or nearly so, like those of many other rosette-forming plants, particularly in such mild climates. The flowers are red, on stalks usually not over eight inches tall.

This species seems to have been found first by William Young, Jr., "Queen's Botanist," who collected plants in the Carolinas in 1766-1768. But he must have gone into Georgia to get it, for it is not known east of the Savannah River, and it escaped the notice of Thomas Walter, who published a "Flora Caroliniana" in 1788, and even of Stephen Elliott, who published a "Botany of South Carolina and Georgia" in 1816-1824. It was first described in 1803 in the "Flora Boreali-Americana" by Andrè Michaux, a French botanist who traveled extensively in all parts of North America that were settled at the time of the Revolution. He said it grew "from the city of Augusta, Georgia, to Florida"; but it is not now known within sixty miles of Augusta, the northeasternmost known locality for it being in Bulloch County, Georgia. From there it ranges northwestward

PLATE 3

(*Right*) SARRACENIA MINOR. Okafinokee Swamp, Georgia.
(*Left*) SARRACENIA MINOR, WITH THE AUTHOR. Okafinokee Swamp, Georgia.

through middle and west Florida to southeastern Louisiana; and in almost every county within its range it is common enough so that one can find it almost any day by looking in favorable places.

Sarracenia minor (Pl. 3) has leaves erect or nearly so, with the hood curved over the mouth of the tube in such a way as to keep out rain falling vertically, though in heavy showers some rain may splash into it. The back of the hood has numerous white translucent spots which serve to light up the interior of the pitcher, and the wing has minute nectar glands scattered along it, which lead ants and other crawling insects up to the mouth of the tube and to destruction within. The leaves are usually less than a foot tall, but in Okefinokee Swamp, Georgia, a height of three feet is often reached, and I have measured one leaf forty-four inches long. (See illustration.) They last pretty well through the winter, but apparently do not function a second season. The flowers are yellow.

This was figured by some of the old European herbalists over two hundred years ago, but was first properly described by Walter in 1788. Michaux, overlooking Walter's description or not recognizing it as belonging to his own plant, redescribed it in 1803 as *S. variolaris,* and this name prevailed for one hundred years, until the older name was resuscitated by the writer.*

This is a common, though not very abundant, plant, chiefly in damp flat pine-barrens, from southern North Carolina to southwest Georgia and southward to the vicinity of Kissimmee, Florida, which is about one hundred miles farther south than any other species of *Sarracenia* extends.† It is not known in Alabama, but Professor J. M. Macfarlane found it once near Ponce de Leon in west Florida. It can often be recognized from a moving train, especially when it is in bloom.

Sarracenia rubra is a slender dull-colored plant with leaves and flower stalks about a foot tall, or sometimes more, but usually less.

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*Bull. Torrey Bot. Club **30**:331-332. 1903.

†In an article on the Everglades by Dix and MacGonigle in the *Century Magazine* for February, 1905, there is a sketch purporting to show some of the characteristic plants on the islands, in which a Sarracenia (species unrecognizable) appears growing on the trunk of a tree with some orchids and ferns! The artist, however, carried his "poetic license" too far, not only in making Sarracenia an epiphyte, but also in attributing it to that part of Florida at all, for no member of the genus is known within one hundred miles of the Everglades.

The leaves are erect or nearly so, with tubes an inch or less in diameter at the top, and roundish ascending hoods with dark red veins. The flowers are red, as the name implies. A double-flowered form has been found by Dr. W. C. Coker near Hartsville, S. C.*

Like the preceding, this was first described by Walter in 1788. It is probably the least abundant member of the genus, and a person unacquainted with it might look for it for several days without finding it. It is so inconspicuous that it never figures in car-window notes. But it has a fairly wide distribution, from North Carolina to west Fliroda and southeastern Mississippi. It is not confined to the pine-barrens,† but grows equally well in the region of mixed pine and hardwood forests a little farther inland, also among the fall-line sandhills, and even in a few places among the mountains of North Carolina, over 2,000 feet above sea-level.‡ Apparently no one has yet photographed it in its natural surroundings.

Sarracenia Sledgei is intermediate in many respects between the preceding species and the next, and might be regarded as a hybrid between them, but for the fact that it grows in many places far removed from either. (Of course it is conceivable that a plant of hybrid origin might perpetuate itself and extend its range over a considerable territory, and it has been suggested that many if not most species have originated in that way; but no authentic case of a self-perpetuating hybrid growing under perfectly natural conditions seems to be known.)

The oldest known specimens of this plant were collected by Thomas Drummond in southeastern Louisiana in 1832; but it was quite generally confused with *S. flava* until separated by Professor J. M. Macfarlane of the University of Pennsylvania, our greatest authority on this family of plants, in 1904. At that time, however, he erroneously identified it with Elliott's *S. Catesbaei* (of which more anon). Discovering his error a couple of years later, the plant was left without

*See Plant World **12**:253-254. 1909; Plant Life of Hartsville, p. 80. 1912.

†For a map showing the approximate location of the southeastern pine-barrens see Journal of Geography **15**:42. Oct. 1916.

‡An amateur botanist in middle Georgia told me several years ago that he had seen a *Sarracenia* in the northern part of Newton County; which is the only record of the occurrence of that genus in Georgia outside of the coastal plain. I never had an opportunity to visit the locality, but would not be much surprised to find *S. rubra* there.

PLATE 4

(*Above*) SARRACENIA FLAVA var. OREOPHILA. Cherokee County, Alabama.
(*Below*) SARRACENIA FLAVA. Colquitt County, Georgia.

a name, and early in 1907* he named it after Dr. W. H. Sledge, of Mobile, who first sent him specimens of it.

It is fairly common in wet pine-barrens from the west side of Mobile Bay to eastern Louisiana, and has been collected in Smith, Henderson, and Hardin counties, Texas; being the only southern pitcher-plant known west of the Mississippi River. East of Mobile Bay I have seen a few specimens in the southern part of Baldwin County, Alabama, and what appears to be the same thing (though it may be a variety of the next) in boggy places among the long-leaf pine hills in Chilton and Autauga counties, near the center of the State.

Sarracenia flava (Pl. 4) is a showy plant with straight erect trumpet-shaped leaves averaging about a foot and a half tall, and two inches or so in diameter at the mouth of the tube. They are bright lemon yellow (or green in shady places), with an irridescent purple spot, or a cluster of purple veins, on the throat or neck, which doubtless serves to lure insects to their destruction. Unlike most of the species previously enumerated, this regularly bears two very different kinds of leaves. The conspicuous insect-catching ones die down in the fall, and are immediately succeeded by green sword-like ones somewhat shorter, which last through the winter. (See illustration.) The flowers are yellow, on stalks usually shorter than the leaves; and there are few flowering plants so nearly yellow throughout as this one.

This striking plant was probably first collected at least three hundred years ago by some of the early botannical explorers of Virginia and North Carolina, and it was in cultivation in Europe soon afterward. The present name dates from the time of Linnaeus. It is doubtless the most abundant plant of its family, though not the most widely distributed. In some parts of its range, particularly in Georgia, there may be as many as ten thousand plants to the acre, making a mass of bright color that can be seen from afar. Its favorite habitat is sandy gentle slopes perpetually moistened by seeping water; it is rarely found in flat pine woods, in ponds, or in peat bogs. It extends from a few miles south of Petersburg, Virginia,† southward

*Journal of Botany 45:4. Jan. 1907.
†See Torreya 4:123. Aug. 1904; Bull. Torrey Bot. Club 34:371. 1907.

to middle Florida (Wakulla County), and westward to Baldwin County, Alabama, where it is rather scarce. Its range does not seem to quite meet that of its near relative, *S. Sledgei*. In North Carolina it is common among the fall-line sandhills (where a traveler on the main line of the Seaboard Air Line can see it any day in summer), as well as nearer the coast, and it is known also in the Piedmont region; but in Georgia it seems to be confined to the pine-barrens.

Several minor horticultural varieties of this species, based on color differences, have been described, and there is a wild variety that deserves special mention. In northeastern Alabama, particularly on the Cumberland Plateau in Marshall, Jackson, and DeKalb counties, and in the Coosa Valley in Cherokee County, in moist sandy places near streams, is a plant similar to *S. flava*, but not typical of that species. It was found by two or three collectors in the last decade of the nineteenth century, and was referred by Dr. Charles Mohr in his *magnum opus*, the plant life of Alabama,* to the long-lost *S. Catesbaei* of Elliott, which was described from South Carolina three-quarters of a century before. Almost contemporaneously Mr. T. H. Kearney, in a discussion of the distribution of certain coastal-plain plants represented by identical or closely related forms in the Southern mountains,† applied the name *Sarracenia flava var. oreophila* to it, but gave no description. Besides the slight differences pointed out by Dr. Mohr, who saw the plant only in summer, there is another that may be important. The sword-like winter leaves, instead of being nearly straight as in the pine-barren form illustrated herewith, are strongly recurved, and considerably shorter than the summer leaves. But this plant should be studied a little more before it is formally named. What appears to be the same thing was collected, probably in the third quarter of the last century, by Dr. Hugh M. Neisler, who lived at Butler, Georgia, among the fall-line sandhills, and presumably got his specimens somewhere in that neighborhood.

*Contr. U. S. Nat. Herb. **6**: 79. 531. 1901. See also, Mohr, Bull. Torrey Bot. Club **24**: 23. 1897; Harbison, Biltmore Bot. Stud. **1**: 155. 156. 1902; Harper, Torreya **6**: 114. 1906.
†Science II. **12**:833, 837. Nov. 30, 1900.

PLATE 5

(*Above*) SARRACENIA DRUMMONDII. Walton County, Florida.
(*Below*) SARRACENIA DRUMMONDII. Mobile County, Alabama.

Sarracenia Drummondii (Pl. 5) has leaves of about the same size and shape as those of *S. flava,* except for being a trifle slenderer; but the upper parts are white with a network of reddish veins, and the lower parts green; the hoods are covered with stiff hairs on the inner surface, and the flowers are red. It produces some sword-like leaves in the fall, but not so regularly or abundantly as does *S. flava.*

This handsome plant was apparently first noticed near Pensacola, Florida, early in August, 1775 (or 1777?*) by William Bartram, a noted naturalist of that time, who attempted to describe it in his Travels (1791) under the name of *S. lacunosa;* but he seems to have gotten *S. minor,* which does not grow so far west (or possibly *S. Sledgei,* which does not grow so far east) mixed with it in his memory, for his description fits *S. minor* better. C. C. Robin, a French explorer who was not a botanist, traveled through the South from 1802 to 1806, saw the same plant near the same place, and published a recognizable description of it in his narrative (1807), although he mistook the leaves for flowers, as many other non-botanists have done since. The erratic naturalist Rafinesque ten years later dug out this description and applied the name *Sarracenia leucophylla* to it, but that has never been taken seriously on account of Rafinesque's well-known eccentricity and his rather unwarranted procedure in giving a name to a plant he had never seen, on the strength of an imperfect description. The species was first properly described in 1836 by H. B. Croom, who did not refer to Bertram or Robin, but had seen specimens collected near Appalachicola by Drummond in 1835 and by Chapman in 1836. (These same old specimens are now in the Torrey Herbarium at the New York Botannical Garden.)

It is known in a few places in southwest Georgia, and inland in Alabama as far as Crenshaw County, is abundant in west Florida and southwestern Alabama, but stops rather abruptly near the Alabama-Mississippi line. It grows in sandy bogs, and especially in the wet gently sloping savannas which are very characteristic of the coun-

*The dates in different chapters of Bartram's Travels are inconsistent, and no one seems to have determined which ones are correct. There is a little contemporary evidence in Darlington's "Letters of Bartram and Marshall," and more may yet turn up.

try within fifty miles of Mobile Bay. In some places it is just as abundant and conspicuous as *S. flava* is farther east.

The known natural hybrids will now be discussed briefly. It is not necessary to describe them, as each is almost exactly intermediate in appearance between the parent species. They bloom less frequently than the true species, and the flowers of one or two have never been seen at all. They are nearly always found in the immediate vicinity of their parents. *Sarracenia purpurea* is the parent of two of the known hybrids, *S. psittacina* of one, *S. minor* of two, *S. flava* of three, and *S. Drummondii* of two. No natural hybrids of *S. rubra* are certainly known, though Asa Gray in the first volume of his Synoptical Flora of North America (published in 1895, several years after his death) mentions the existence of plants which appear to be hybrids between this and *S. purpurea,* but without giving any locality. No hybrids of *S. Sledgei,* the most recently described species, have yet been reported, but their existence is not at all unlikely, for there are three other species that associate with it.

Sarracenia purpurea x *flava* has quite a long history. One of the colored figures in Catesby's "Natural History of Carolina," first published in 1743, has been thought to represent it, but the figure is a poor one, and is probably intended for *S. flava,* which Catesby could hardly have helped seeing on his travels, and does not mention otherwise. Early in the nineteenth century Dr. James Macbride collected in Chesterfield County, South Carolina, a pitcher-plant without flowers, which was described by Elliott in 1821 in his "Botany of South Carolina and Georgia" as *S. Catesbaei,* on account of its supposed resemblance to Catesby's figure. The other *Sarracenias* known to Elliott were *purpurea, rubra, flava,* and *minor,* and of these he said the new plant was most closely related to *flava.* Croom, examining the same specimen a few years later, asserted that it did not differ materially from *S. flava;* but Professor Macfarlane, who saw it about 1906, recognized it as this hybrid, which he had already known for some years.

In the *Gardeners' Chronicle* (London) for July 9, 1881, there is a brief notice of a plant called by British horticulturists *Sarracenia Williamsii,* which had been received in a shipment of plants from

PLATE 6

(*Above*) SARRACENIA FLAVA x MINOR. Coffee County, Georgia.
(*Below*) SARRACENIA FLAVA x DRUMMONDII. Geneva County, Alabama.

America (locality not specified), and was thought to be a natural hybrid between *purpurea* and *flava*. In June, 1893, Professor Macfarlane found two specimens, in company with the parent species, near Wilmington, N. C., where their hybrid origin was practically certain. In 1905 he found 117 specimens of the same thing in one day in Holmes County, Florida, and a few in Baldwin County, Alabama. The same two species were crossed to make one of the first artificial hybrids in the genus, in 1874.

S. purpurea x *Drummondii* was discovered in company with its parents in Baldwin County, Alabama, by Professor Macfarlane in 1905, and in the northern part of Walton County, Florida, by the writer in 1911. Artificial hybrids with this parentage were described in England in 1887.

S. psittacina x *minor* was found by the writer in Colquitt County, Georgia, in 1902, and in Coffee, Irwin (now Ben Hill), and Wilcox counties in 1904.* All these localities are in the Altamaha Grit region or rolling wire-grass country. This hybrid produces flowers and fruit more freely than most of the others. Artificial hybrids were known in England as long ago as 1881, under the name of *S. formosa.*

S. flava x *minor* (Pl. 6). No artificial hybrid between these two yellow-flowered species is certainly known, but in 1901 I found a single specimen of the natural hybrid in Bulloch County, Georgia, and the following year several others in Coffee County.† Of the photographs taken at the latter place in 1902 and 1904 two have been published already, and another appears here. Professor Macfarlane found the same thing near Summerville, S. C., in 1903.

S. flava x *Drummondii* (Pl. 6). These two species were probably the first to be crossed artificially, this having been done by Dr. David Moore at Glasnevin, Ireland, in 1873, or thereabouts. The first intimation of a natural hybrid between them seems to be in the 1893 catalogue of Pitcher & Manda, florists, of Short Hills, N. J., where there is a full-page halftone of a plant called *Sarracenia Mandaiana,* said to "have been collected growing in company with *S. flava* and *S. Drummondii,* of which it is no doubt a natural hybrid." In 1895 and 1901,

*Bull. Torrey Bot. Club **33**: 236, 237. 1906.
†Bull. Torrey Bot. Club **31**: 22. 1904; **32**: 463. 1905.

at two places about a mile apart near Americus, Georgia, I found a few specimens corresponding very well with that illustration (which happened to come into my possession in the former year). *S. rubra* and *S. Drummondii* were growing close by in both places, but the nearest known station for *S. flava* was (and is) over twenty-five miles away, which made me doubt the possibility of that's being one of the parents, or of my plant being a hybrid at all. The flowers were unknown to me, as they were to Pitcher & Manda. In 1903* I referred it to the problematical (and likewise flowerless) *S. Catesbaei,* but Professor Macfarlane's investigations of that plant, published in 1907, showed that I was mistaken. In June, 1906, I found some very similar plants (illustrated herewith) about three miles east of Geneva, Alabama, in company with *S. Drummondii,* though here again there was no *S. flava* (nor *S. rubra*) in sight. But in the meanwhile Professor Macfarlane in 1905 had found plants whose hybrid origin was evident near Bay Minette, Alabama.

The occurrence of this plant remote from one of its supposed parents is somewhat of a puzzle. Whether *S. flava* had once grown nearer by and its hybrid progeny had maintained itself independently for a long period, or the pollen can be carried by insects much farther than we realize, or the supposed hybrid is really a mutation or a valid species, remains to be proved.

One compound natural hybrid has been reported by Professor Macfarlane, who has found near Ponce de Leon, Florida, what appears to be *S. purpurea* x *flava* crossed again with *S. flava.* The artificial hybrids that have no known wild counterparts need not be discussed here, as they are known only in European greenhouses and have no status as American plants.

The known distribution of the species of *Sarracenia* in the United States may be summed up by States as follows: East of the Great Plains and north of the Ohio and Potomac rivers *S. purpurea* is found in every State, with no other species of the genus. In West Virginia, Kentucky, and Tennessee apparently no pitcher-plant has been seen by any botanist now living, though *S. purpurea* has been

*Bull. Torrey Bot. Club **30**: 333-335. 1903.

reported more or less indefinitely from the last two. In Virginia only *S. flava* is certainly known (and that is scarce), but there are vague references to *S. purpurea* in the literature. (In the remaining States the species will be listed as nearly as possible in order of abundance.)

North Carolina has four species: *flava, purpurea, minor,* and *rubra;* and one hybrid, *S. purpurea* x *flava.*

South Carolina has the same, probably in the same order of abundance, with *S. minor* x *flava* added.

Georgia has six good species, *flava, minor, psittacina, Drummondii, rubra,* and *purpurea,* possibly also the subspecies *S. flava oreophila,* two unmistakable hybrids, *psittacina* x *minor* and *minor* x *flava,* and what appears to be *S. flava* x *Drummondii.*

Florida has the same true species as Georgia, but in a different order, about as follows: *minor, psittacina, Drummondii, flava, purpurea, rubra.* Also two simple hybrids, *purpurea* x *flava* and *purpurea* x *Drummondii,* and what appears to be a compound hybrid.

Alabama has six species, *Drummondii, purpurea, Sledgei, flava, psittacina,* and *rubra,* one subspecies, *flava oreophila,* and three hybrids, *purpurea* x *flava, purpurea* x *Drummondii,* and *flava* x *Drummondii.*

Mississippi has *Sledgei* and *psittacina,* and possibly also *purpurea, rubra,* and *Drummondii* at the extreme eastern edge of the State.

In Louisiana only *Sledgei* and *psittacina* are certainly known, and in Texas only *S. Sledgei.*

Naturally a great deal has been written about this interesting family of plants, but the short notes, other than a few already cited in the foregoing pages, are too numerous, and the longer papers mostly too inaccessible, to be mentioned in a popular article like this. It must be acknowledged here, however, that most of the facts above set forth that are not based on personal experience are taken from Professor Macfarlane's writings, particularly his 39-page monograph of the family in Engler's Pflanzenreich, published in 1908. That contains references to the most important previous literature, some of which I have also used.

COLLEGE POINT,
LONG ISLAND.

EXTENSION OF THE RANGE OF *PRUNUS UMBELLATA* INTO NORTH CAROLINA

By J. S. Holmes

During a study of the forest conditions of Stanly and other southeastern Piedmont counties last summer (1917) I came across a species of plum tree which I had not before seen. Having no books with me, I sent a specimen to Dr. W. C. Coker of the State University and he immediately identified it as *Prunus umbellata.*

The two species of plum common to North Carolina are *Prunus americana,* the hog plum, and *Prunus augustifolia,* the chickasaw plum. These two are generally distributed throughout the State, though the former is more abundant in the upper districts and the latter in the middle and lower districts.

The fruit of *Prunus umbellata,* known frequently as the sloe or bullace plum, is much smaller than that of either of the above species. It can hardly be classed as edible, being very sour and bitter; however, it is used to some extent in making jelly, probably mixed with the larger and more palatable fruit of the other two species. The tree is small, the largest one seen not exceeding six inches in diameter and twenty-five feet in height; the twigs are slenderer and less stiff than the chickasaw plum and the tree is hardly as tall or as large as the hog plum, which it more nearly resembles. It occurs in old-field pine stands and on the borders of fields and roadsides, usually in rather dry situations in sandy or gravelly soil.

Its distribution in North Carolina as established by me during last summer's field season is confined to the Pee Dee River region, in the counties of Anson, Stanly, Montgomery, and Richmond. It was most common within a few miles of the river, though in Stanly County it was seen twelve miles west of that river and in Montgomery County sixteen to eighteen miles east of it. The locality where it seemed to be most abundant was on the east side of Stone Mountain in Stanly County, a short distance below the mouth of the Uharie River and only a few miles south of its northern limit at Badin in the same

county. As far as I could learn, it is not distinguished from the other plums locally, all of them together being known as wild plums.

So far as I am aware, *Prunus umbellata* has not been known to occur nearer to us than the coast of South Carolina, and Dr. Charles S. Sargent of the Arnold Arboretum, probably our leading authority on the distribution of trees in the United States, so records it in his manual of the Trees of North America, published in 1905. In this work he gives the distribution as follows: Sandy bottom lands and along the borders of the forest of longleaf pine; South Carolina to Mosquito Inlet, Florida, usually in the neighborhood of the coast, and from Tampa Bay to western Louisiana and southern Arkansas.

In a letter recently received from Dr. Sargent he says:

"I do not find in this herbarium any specimen from South Carolina, but it is so common in the coast region of Georgia that I feel quite sure that it grows in South Carolina. I have collected it near Augusta and we have Georgia specimens from McIntosh County, Milam, Thomasville, Bainbridge, and Albany."

Dr. Small, in his Flora of the Southeastern United States, gives its distribution as "about river swamps and hammocks, South Carolina, Florida, Louisiana, and Arkansas." Dr. Small distinguishes between this species and *Pruns injucunda,* which occurs in the granite districts of Georgia and Alabama, while Dr. Sargent makes the latter a variety of the former. The difference seems to be largely in the amount of pubescence; *umbellata* having little or none, while *injucunda* has pubescent twigs and the under side of the leaves are likewise pubescent. Trees with smooth thin leaves and others with quite pubescent leaves were found growing fairly close together in the Pee Dee region, and Dr. Sargent says in his letter to me that the species varies very much in pubescence, there being many specimens in the herbarium of the Arnold Arboretum which are more pubescent than those I sent him.

Miss Alice Lounsberry, in her charming popular work on "Southern Wild Flowers and Trees" says of *Prunus injucunda:*

"Hardly is there a tree or shrub of more delicate and chaste beauty than this wild plum when in full bloom and the tiny young leaves are just beginning to show themselves."

Of *Prunus umbellata* she says:

"It has a similar look to *Prunus injucunda.*"

Perhaps, then, this may prove to be a valuable addition to our ornamental trees, if not to our economic assets. Certainly in July when the reddish purple fruit is hanging in abundance from the slender twigs it is a very pretty sight. The fruit hangs on a long while and the leaves remain on in the fall considerably longer than they do on the chickasaw plum. The photo given in Plate 7 shows a tree 5½ inches in diameter (4½ feet from the ground) and 20 feet in height. This tree was in an old-field pine stand one mile west of Gibson's Mill, Richmond County, North Carolina. The picture was taken by the author November 17, 1917.

In Dr. M. A. Curtis' "Woody Plants of North Carolina," published in 1860, he gives, in addition to our two common plums, the Sloe (*P. spinosa* Linn.?). He says:

"I have seen this only in Lincoln County, where it was pointed out to me by Dr. Hunter, and called by the above name. As I have no notes upon this small tree, I am now in uncertainty whether it be identical with the English Sloe or Blackthorn, which is naturalized in some parts of the country, and is considered by the best botanists to be the parent of the common cultivated plum (*P. domestica*, Linn.)."

It is possible that this was an isolated specimen of *P. umbellata,* as the Lincoln County line is only about forty miles west of its known range in Stanly County, but neither this nor the Blackthorn, so far as I know, has been otherwise reported from North Carolina. The two trees are not much alike—the European Sloe or Blackthorn having sharp stiff thorns and the twigs themselves are stiff and unyielding. It spreads by shoots from underground rootstocks, these sprouts being used largely for making walking stick. The fruit is black with a bloom and is "intensely austere and astringent."

PLATE 7

PRUNUS UMBELLATA (SLOE OR BULLACE PLUM).

Photo by J. S. Holmes.

PLATE 8

VIRGINIA
ALLEGHANY
SPARTA
DOBSON
SURRY
STOKES
DANBURY
ROCKINGHAM
WENTWORTH
CASWELL
YANCEYVILLE
WILKES
N. WILKESBORO
YADKIN
YADKINVILLE
FORSYTH
WINSTON-SALEM
GUILFORD
GREENSBORO
ALAMANCE
GRAHAM
DAVIE
MOCKSVILLE
YADKIN RIVER
IREDELL
STATESVILLE
LEXINGTON
DAVIDSON
RANDOLPH
ASHEBORO
PITTSBORO
CHATHAM
NEWTON
CATAWBA
SALISBURY
ROWAN
CATAWBA RIVER
LINCOLN
CONCORD
CABARRUS
STANLEY
ALBEMARLE
TROY
MONTGOMERY
CARTHAGE
MOORE
LEE
CHARLOTTE
MECKLENBURG
PEE DEE RIVER
HOKE
UNION
MONROE
WADESBORO
ANSON
RICHMOND
ROCKINGHAM
SCOTLAND
LAURINBURG
SOUTH CAROLINA
DISTRIBUTION OF PRUNUS UMBELLATA IN NORTH CAROLINA 1917

The accompanying map shows by black rectangles the different locations where *Prunus umbellata* was seen.

These occurrences (Pl. 8) may be described briefly as follows:

ANSON COUNTY.

Morven Township, one mile south of Cairo.

STANLY COUNTY.

Big Lick Township, three miles east of Oakboro.
Albemarle Township, one mile north of Jacobs Creek on River Road.
W. M. Kirk's place east of Stone Mountain; and near Stony Mountain School.
Harris Township, one-half mile south of Badin.

MONTGOMERY COUNTY.

Rock Springs Township, near Harrisville.

RICHMOND COUNTY.

Steeles Township, Concord Church.
Rockingham Township, Zion Church and one mile south of Dockery's Store.
Beaver Dam Township, one mile west of Gibson's Mill, and near Beaver Dam Church.

CHAPEL HILL, N. C.

ADDITIONS TO THE ARBORESCENT FLORA OF NORTH CAROLINA

By W. W. Ashe

It was not intended by the authors* of the "Trees of North Carolina" to include all the trees in the State, since it is stated in the introduction that a number of others might be added. It might be well, however, to add to this already very full enumeration such others as are known to occur that the list may be as complete as possible. The addenda, omitting any hawthorns or semi-shrubs and allowing for the elimination of two from the original list by treating them as varieties, increases the number of species to 180 in place of 166. If to these are added the large number of smaller trees and semi-shrubs, including the arborescent hawthorns, the number nearly reaches 240, and with the inclusion of some of the best marked varieties exceeds 260. It is believed that even this total is incomplete, and that fuller investigations will further augment it, for many portions of the State have never yet been carefully explored.

Salix discolor Muehl. A small tree which occurs along mountain streams.

Betula papyrifera cordifolia (Regel) Fern. The canoe birch occurs in the Black Mountains but is not known to occur between this station and Connecticut and northern New York. (See *Rhodora*, Apl. 1918.) It is readily separated from the other birches on these mountains by its pinkish or brownish bark, which is in thin papery layers, as well as by its deeply cordate leaves, and declining, not erect, fruit cone.

Several forms of Hicoria (the generic name employed for *Carya* in Trees of North Carolina) are not noted.

Varieties of Hicoria pallida Ashe. This species varies much in the form of fruit and nut. The type can be considered the fruit form which is common around Chapel Hill and Raleigh, N. C., where

*W. C. Coker and H. R. Totten, Chapel Hill, N. C. Published by the authors 1916.

this tree was first studied. This form is shown in *Garden and Forest*, **10**: fig. 39, 5 and 6. The fruit is slightly oblong, compressed, rounded at both ends; nut compressed, slightly or not angled, rounded or subcordate at apex, pale brown or mealy; husk thin, usually splitting so as to free the nut. The following forms are sufficiently distinct to merit notice:

H. PALLIDA PYRIFORMIS n. c. (*Carya p.* var. Ashe: Bul. Charleston Mus. **14**: 11. 1918). Fruit slightly compressed, ficiform, 2-2.5 cm. long, with a distinct neck; not obovate, husk very thin not splitting so as to free the nut (Gard. & For. **10**: fig. 39, 7 and 8: 1897). Virginia to Alabama, in the Piedmont section and lower mountains.

H. PALLIDA ARENICOLA n. c. (*C. pallida* var Ashe, l. c.). Fruit large 2.5-4 cm. long, oblong but with a stipe, 4-angled by winged husk, nut oblong, more or less angled and pointed. Deep sandy soil in the coastal plain of North Carolina to Georgia.

H. PALLIDA APPOSITA n. c. (*C. pallida* var. Ashe, l. c.). Fruit oblong to slightly oval, 2-3 cm. long, somewhat compressed, husk 3-4 cm. thick, nut dark brown, angled, resembling that of *Hicoria alba* (Gard. & For. **10**: fig. 39, 9, 10, 11.

This tree is extremely close to *Hicoria buckleyi* (Dur.) n. c. (*Carya buckleyi* Dur.: Pro. Phil. Acad. Nat. Sci. **12**: 547), and fuller investigation may show that it is only a variety of *H. buckleyi*. The chief points of difference seem to be that the fruit of *buckleyi* is puberulent and subglobose. The fruit of all forms so far referred to *pallida* are glabrous. Pubescence of fruit is not considered a constant character in the shagbarks and may not be in this group. The fruits of nearly all species of this genus vary widely in shape.

HICORIA VILLOSA (Sarg.) Ashe has been regarded as being the same as *H. pallida* with very slight difference in fruit, that of *villosa* as originally figured (Sargent: Silva **7**: 167) being slightly obovate, the nut also being slightly obovate. The leaves in herbarium specimens show no characters which justify separating *villosa* from *pallida*. The plate of *villosa* (Sargent l. c.) shows the pistillate flower to be

different from that of *pallida,* especially in the absence of the broad stigmatic lobes, but is strongly suggestive of that of HICORIA ARKANSANA n. c. (*Carya arkansana* Sarg. Trees and Shrubs, **2**: 203. 1913). though the mature fruits are very different. A more careful study of the flowers and buds of *pallida* and *villosa* may furnish grounds for their separation, but at present it seems preferable to consider both of them as varieties of *pallida,* becoming respectively H. P. VILLOSA n.c., which is separated from the type by having usually fewer leaflets and more rusty pubescence; and H. P. ARKANSANA n. c., the twigs and buds of which are more or less pubescent. The color of the anthers is not constant, being either yellow or red, and *pallida* varies greatly in the scurfiness on the fruit. All of these forms are characterized by the peltate scales which clothe the lower surface of the leaves and which separates these species when free from pubescence from *porcina* and *ovalis* and when pubescent from *alba,* species which never bear such scales.

VARIETIES OF HICORIA ALBA (L.) Brit. This species has three forms in North Carolina: the typical with a medium-sized brown nut; *H. alba maxima* (Nutt.) Brit. with a very large, 3-5 cm. long dark brown 4-angled nut; and *H. alba albicans* n. c. (*Carya* var. Ashe, l. c.) with a small scarcely 2 cm. long sharply 4-angled white nut. The last two occur at Raleigh.

VARIETIES OF HICORIA OVATA (Mill.) Brit. In addition to the two shagbarks described in the Trees of North Carolina, three and possibly four varieties of *H. ovata* occur. One, *H. ovata nuttallii* (Sargt.)* n. c., differs from the type in the somewhat smaller but globose fruit and occurs associated with the type form throughout the western part of the State. As in the type the husk is sometimes puberulent on the outer surface.

The type and the above variety have the fruit grooved at the sutures of the husk and often impressed at apex and base. Another variety, *Hicoria ovata grandis* n. c. (*Carya ovata* var. Ashe, l. c.), has fruit as large or larger than in the type and often somewhat oblong, an even

*_Carya ovata nutallii_ Sarg. T. & S. **2**: 208. 1913.

surface, full and rounded at the ends, and usually pubescent; the lower leaves often of 7 very large tomentose leaflets. It occurs through the Southern States from eastern North Carolina to Missouri, usually at low altitudes and in the larger river swamps. Another variety, *H. ovata holmesiana* n. c. was proposed as *Hicoria holmesiana*,* and was described as being smooth, having smaller fruit 2.3-3 cm. in diameter, smaller than the type. It was based on material from New England, the type coming from Mt. Tom. This form seems to be pubescent as well as glabrate. It occurs in North Carolina only in the higher mountains. A smaller tree in North Carolina than the common shagbark, it has only five smaller and usually less pubescent leaflets, and smaller subglobose fruit and nut; buds and twigs glabrate or pubescent but scarcely larger than those of the Carolina shagbark. This was originally proposed as a species and may be such. Another form which should be looked for in the western portion of the State and particularly in the mountains is *H. ovata fraxinifolia* n. c. (*C. var.* Sarg.: T. & S. **2**: 207. 1913). This has five very narrow leaflets, orange-brown twigs, and a thick spongy husk which is very rugose when dry.

HICORIA AUSTRALIS n. c. (*Carya* Ashe, Bul. Ch. Mus. **14**: 12). This shagbark occurs on the edges of swamps in the coastal plain south of Sampson County. It is a slender tree, 80 to 100 feet in height, about 2 feet in diameter, with bark scaly in long strips, and is closely related to the Carolina shagbark, being, when foliage is mature, essentially glabrous throughout, *including the fruit,* but is every way larger and stouter; twigs, buds, fruit, nuts, and leaflets which are broadly lancelate and sharply serrate, those of the Carolina shagbark being much narrower. The fruit is glabrous, sulcate, and slightly impressed at each end.

VARIETIES OF HICORIA OVALIS (Wang.) n. c.† Dr. Sargent regards *ovalis* as being the oldest specific name applicable to this hickory, forms of which have been called *microcarpa* and *odorata*. This

*Notes on Hickories (1896).
†*Carya ovalis* (Wang.) Sarg. T. & S. **2**: 208. 1913.

species and all of its varieties is the large tree, commonly called in North Carolina red heart or sometimes scaly bark (not shagbark) hickory, and is very common, especially on the red clay soils through the Piedmont. The ample lower leaves frequently have red petioles and the 5 to 7 leaflets are always dotted below with numerous resinous globules, which accounts for its balsmic fragrance in the early spring, hence Marshall's name *odorata* for this tree. Wangenheim in his ponderous German volume of 1787 has clearly described and figured the form he had before him: Fruit oval, rounded at the base, pointed at the top, the thin husk splitting to the base and freeing the nut, which is slightly oblong and flattened, and angled and pointed at the ends. This is *Hicoria microcarpa* (Nutt.) Brit.

*H. ovalis obcordata** n. c. This form has the "fruit subglobose to short oblong or slightly obovate, the nut compressed, broadest above the middle, rounded at base, and usually obcordate at apex." It is frequent especially in the mountains, but is not so common as the preceding.

H. ovalis odorata† n. c. This variety according to Dr. Sargent has fruit subglobose, flattened, husk thin, very glandular and splitting to the base, the nut whitish, thin-shelled, not ridged. This form has also been included under *H. microcarpa.*

H. ovalis obovalis‡ n. c. This is one of the frequent forms in the State and has the fruit obovate, and the compressed small nut of the same shape.

H. ovalis megacarpa n. c. Dr. Sargent has described *Carya megacarpa*§ from material from Rochester, N. Y. He associates with the Rochester form a tree which occurs in the immediate vicinity of the coast from near Beaufort, N. C., southward. It is closely related to and probably best regarded as a variety of *Hicoria ovalis.* This form has extremely large buds, the outer scales of which drop early, stout glabrous bright red-brown twigs; mostly 5 firm glabrous leaflets thickly dotted beneath with resinous globules and large fig-

Carya ovalis obcordata* (M. & W.) Sarg., T. & S. **2:208. 1913.
†*Carya ovalis odorata* Sarg. T. & S. **2**: 208. 1913.
‡*Carya ovalis obovalis* Sarg. T. & S. **2**: 209. 1913.
§Trees and Shrubs **2**: 201. 1913.

shaped fruit, approximately 2.5 cm. thick, the nut unangled, dark brown and thick walled, the husk nearly black when dry, thin, splitting only at top, not freeing the nut.

VARIETIES OF HICORIA PORCINA (MX.) Raf. (*Juglans porcina* Mx. f.: Arb. Am. 1: 306. 1810). This would seem to be, in the present state of our information, the preferable name for this species, rather than *Hicoria glabra* (Mill.) Brit. In addition to the type with five glabrous leaflets, destitute or nearly so of resinous globules on their lower surface and fig-shaped fruit on which the thin husk splits only at the top, the following other forms occur around Chapel Hill, N. C.: var. *hirsuta* n. c. (*Hicoria glabra* var. Ashe, Notes on Hickories), with the petioles and lower surface of leaflets soft white pubescent, the fruit as in the type; and var. *reniformis* n. c. (*Carya* var. Ashe, Bull. Ch. Mus. **14**: 2. 12), with subglobose compressed fruit almost without a stripe, and subcordate at apex. At Chapel Hill the pubescent form of this tree invariably has a fig-shaped fruit, while on a sandy ridge in the western part of Orange County, N. C., it has a short obovate fruit. *H. porcina acuta** (Sar.) n. c. should also be looked for in this State. It has fruit and nut pointed.

Another hickory which is to be looked for in southeastern North Carolina is H. SIMILIS n. sp. This is one of the most distinct of the *porcina* races and can be regarded as its South Atlantic coastal plain representative.

Leaflets prevailingly 7, rarely 5, somewhat larger especially broader than those of *porcina,* glabrous or essentially so before mature, by which time devoid of resinous globules. Twigs slender, dark red-brown (not purple brown as in *ovalis*), scarcely if any stouter than in *porcina;* terminal buds oblong-ovate, the outer scales short, carinate, bristle-tipped and persistent. Fruit ficiform, larger by one-fourth or one-third than that of *porcina,* nearly as large as that of *H. ovalis megacarpa* but more tapering at the base; husk very thin, splitting only at the apex; nut pale brown, obovate, slightly com-

Carya porcina acuta Sarg. T. & S. 2: 200. 1913.

pressed, not angled, thick walled. A tree 10-20 m. tall, growing along the margins of pine barren swamps from Lumber City, Ga. (type locality) to Georgetown, S. C. The absence of resinous globules and the oblong-ovate buds ally this form to *porcina* rather than *megacarpa*.

VARIETY OF HICORIA CORDIFORMIS (Wang.) Brit. There is in addition to the typical form with the large obcordate nut, a form, *H. c. elongata* n. c. (*Carya* var. Ashe l. c.), with oblong acute fruit and an oblong pointed nut. It has been found only in the mountains of North Carolina.

QUERCUS PAGODA Raf. The swamp red oak is considered in the Trees of North Carolina as a species under the name *Q. pagodaefolia*. The form of the southern red oak with large thinly pubescent lower leaves, quite like those of the black oak and upper leaves in shape like those of the Spanish oak (*Q. coccinea*), but closely white pubescent beneath and fruit much like that of the swamp red oak, has been described as variety *leucophylla* of the southern red oak (Bul. Ch. Mus. Apl. 1917). Its affinities seem to be more with the swamp red oak than with the southern red oak, and if regarded as a variety of the former becomes *Q. pagoda leucophylla* n. c. This tree, which has very tough and valuable wood, is among the largest of American oaks.

QUERCUS OBTUSA (Willd.) Ashe. This is the common semi-evergreen water oak of the coastal plain and for industrial uses is the most valuable member of the water-oak group. The leaves are narrow, usually broadest near the middle, and longer than in *Quercus nigra,* and seldom noticeably 3-lobed. Those on vigorous shoots are not toothed and are usually unsymmetrical. The cup encloses about one-third of the nut.

QUERCUS AMBIGUA Mx. This is a form of the northern red oak which occurs on exposed sites in the higher mountains. It is not so

large as the typical form, from which is readily separated by the acorn cup being deeper and having a more pointed base.

QUERCUS MARGARETTA* is variable and some of the nearly related forms from the Gulf States which have recently been proposed by Dr. Sargent should be looked for in eastern North Carolina.

ULMUS FLORIDANA Chapm. This tree, which is confined to the swamps of the coast, is smaller in every way than the white elm. Its leaves are not quite so pubescent and the twigs are quite glabrous. It is common around New Bern.

PLANERA AQUATICA Gmel. occurs in the southern corner of the State.

CELTIS MISSISSIPPIENSIS Bosc., which has thin taper-pointed leaves, often with entire margins, occurs along the larger streams in the eastern part of the State.

CELTIS GEORGIANA Small, which is mentioned in the Trees of North Carolina as a shrub, frequently becomes a small tree, and should be included among the trees.

MAGNOLIA CORDATA Mx. (*Tulipastrum cordatum* (Mx.) Small) has been recorded only from the middle portion of the State, in the extreme northwestern corner of Moore or the adjoining part of Montgomery County. For the yellow-flowered form which has been reported from the mountains the name *Magnolia acuminata aurea* has been proposed (Bul. Ch. Museum **13**:28. 1917).

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*Dr Sargent has proposed (Bot. Gaz. 65. 441. May, 1918) several varieties of *Quercus stellata* Wang. which on account of their slender glabrous, or nearly glabrous, shining reddish-tan twigs would seem better regarded as varieties *Q. Margaretta*. These are Q. M. ARANIOSA n. comb. (*Q. stellata* var. Sarg. l. c.). This variety is based on material from Louisiana, the distribution being given from Alabama to Texas. It seems to differ from the type *Margaretta* only in the more floccose persistent tomentum on the lower surface of the leaves, the more slender branchlets and more scaly bark.

Q. M. PALUDOSA n. comb. (*Q. stellata* var. Sarg. l. c.). This is based by Dr. Sargent on trees growing in a swamp in St. Landry Parish, La. It seems to differ from *Q. Margaretta* only in its more uniformly 3-lobed leaves, the pubescence on the lower surface of which is shorter and more persistent, the sparingly pubescent twigs and more scaly bark.

Q. M. STOLONIFERA n. comb. (*Q. stellata* forma Sarg. l. c.). This variety found near Selma, Ala., is described as a shrub 1.5-2 m. high, forming thickets by subterraneous shoots. It differs further from the type in having smaller and narrower leaves. The same or a closely related variety grows along the Pee Dee River in Anson and Richmond counties, N. C., although it here reaches a somewhat larger size. It has the same characteristic method of vegetative propagation. It is locally known as runner oak.

To the arborescent* service trees can be added a variety and a species: AMELANCHIER LAEVIS CORDIFOLIA n. var., which has the leaves deeply cordate and more broadly ovate than in the type. It occurs in Rabun County, Ga., and foothills of the Blue Ridge in Macon County, N. C.

AMELANCHIER BEATA sp. nov. A virgate shrub or a small tree 3-8 m. in height. Leaf blades ovate to oblong-ovate, and rounded or subcordate at the mostly narrow base, or those at tips of twigs obovate and cuneate at base, 4-7 cm. long, 2-3.5 cm. wide, mostly taper-pointed, finely and regularly serrate, loosely pubescent or unfolding, especially below, nearly glabrous by maturity of fruit except the slender petioles ⅓-½ length of blades. Flowers unknown. Fruit in 5-10-fruited strict compact racemes 4-5.5 cm. long, ripening early in June is 7-9 mm. thick, dark red-purple, glaucous, densely white woolly at the narrow summit, the narrow acute lobes erect or ascending from a carinate base; pedicels and axis more or less pubescent until fruit matures; lowest pedicels in fruit 12-20 cm. long. Style short, 2-2.5 mm. long.

Type from Toxaway Creek, Oconee County, S. C., but locally abundant along foothills of Chattooga Ridge from Brasstown Creek, Oconee County, S. C., to Jackson County, N. C. Separate from *oblongifolia* and *obovalis,* with which confused, by the acuminate leaf blades and long petioles; from *canadensis* by the wolly summit of ovary and longer, narrower ascending or erect calyx lobes.

PYRUS CAROLINENSIS† n. c. On the French Broad River bottoms near Mills River, N. C., occurs this species, which has narrowly ob-

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*The following shrubby form can also be mentioned:
A. AUSTRO-MONTANA sp. nov. A shrub not exceeding 4 m. in height. Leaves 2.5-4.5 cm. long, 1.5-3.5 cm. wide, oval and gradually tapering to the apex from the rounded base, or those at tips of twigs, obovate with cuneate base and abruptly acuminate at apex, finely and sharply, but even at tip often rather distantly serrate, with ascending or incurved teeth, the sinus acute, thin, very dark green above, pale green beneath, more or less bronze on unfolding, and coated below with very loose pubescence which has largely disappeared even from the short petioles before foliage is full grown. Flowers, appearing largely before the leaves, in short, nodding 7-10-flowered pubescent racemes, are about 8 mm. long in bud, 15-18 mm. wide when fully expanded, the spatulate petals 2 mm. wide; calyx small 5-6 mm. wide, rather deep, glabrous without, pubescent within around base of style and sparingly on lobes, the tips of which are reflexed after anthesis. Hypanthemum becoming very broad and deep on the glabrous fruit, which is 10-14 mm. thick, shining, nearly black when ripe early in July, the tips only of the erect lobes being recurved, and is born in 4-7-fruited racemes, which are 3-4 cm. long, the lowest pedicel exceptionally 1.5 cm. long. Type from near Brevard, Transylvania County, N. C. Related to *humilis* in fruit characters.

†*Malus carolinensis* Ashe l. c. **14**: 10.

long crenate or obtusely serrate leaves, 7-10 cm. long, and depressed-globose fruit about 1.2 cm. in diameter, green but often with a very ruddy cheek. A variety of it, *P. c. ellipsoidalis,** has shorter elliptic leaves, serrate only above the middle.

OTHER SPECIES OF PYRUS. In addition to the above and to the two species of crab apple which are mentioned in the Trees of North Carolina, there is a beautiful tree with maple-like leaves (*Pyrus glabrata* (Rhed.) Bail.), which ocurs from Mitchell County, N. C. southward in the mountains. Around Highlands occurs another, *Pyrus elongata* (Rhed.) n. c.,† which has lanceolate, sharply serrate, sometimes lobed, leaves, and small globose fruit often with a red cheek. In the valley of the Tennessee River, in Macon County, occurs *Pyrus platycarpa* (Rhed.) Bail., with elliptic leaves like those of the domestic apple and very large, 10 cm. thick, green pomes. As it is unarmed it has many traits suggesting hybridity with the domestic apple as one parent. Around Asheville two others occur: *P. redolens* n. c.,‡ with oblong crenate leaves and globose green fruit deeply sulcate at apex; and *P. lancifolia* (Rhed.) Bail. with lanceolate unlobed leaves.

SPECIES OF CRATAEGUS. To the large number of red haws which are enumerated might well be added, however, *Crataegus roanensis,* with small bright-red oblong fruit, common in the higher mountains; *C. macrosperma,* with large oblong bright-red fruit, occurring with the preceding; *C. cibilis,* which occurs on the French Broad River near Paint Rock and has scarlet globose fruit 1.8 cm. or more in diameter; *C. brevipedicellata,* having small russet or dull red fruit, frequent in Orange County, and *C. boyntoni buckleyi* (Beadl.)§ n. comb., which is frequent around Asheville. There are about thirty other kinds in the State which become trees.

AESCULUS OCTANDRA PURPURASCENS (Gr.). In the Trees of North Carolina a reference is made to a purple-flowered tree buckeye.

Malus carolinensis ellipsoidalis, idem.
†*Malus elongata* (Rhed.) Ashe. Bul. Ch. Mus. **12**: 37. 1916.
‡*Malus redolens* Ashe, l. c. **12**: 39. 1916.
§*C. buckleyi* Beadl. Bul. Bot. St. **1**: 25. 1901.

Dr. Sargent* at one time expressed doubt as to the occurrence of a red-flowered arborescent buckeye in the southern mountains, and he referred to other species, the name which he had applied to such a form. *Ae. hybrida* D. C., in place of being an Appalachian form seems to be a hybrid developed and first propagated in France. But more recently (Trees of Mount Vernon, 1917)† Dr. Sargent notes cultivated reddish-flowered trees, the seed from which they grew having been brought from West Virginia by Washington. A form of *Ae. octandra* quite similar to the description of some of the Mount Vernon trees having flowers variegated with red and purple, has been collected in Ashe and Yancey counties, N. C., as well as in Johnson County, Tenn., about two miles above Mountain City; and a somewhat different form, with the leaves very pale beneath from near the upper edge of the broadleaf forest on the eastern slope of the Blue Ridge, near the Pinnacle, along the Mount Mitchell Railroad.

AESCULUS PAVIA L. the red-flowered buckeye of the coastal plain frequently becomes a small unsymmetrical tree 15 to 20 feet high.

U. S. FOREST SERVICE,
WASHINGTON, D. C.

*T. & S. 2:266. 1913.
†Published by the Mount Vernon Society.

REPORT OF AN INVESTIGATION AS TO CAUSE OF DEATH OF CHICKS IN SHELL IN ARTIFICIAL INCUBATION

By H. B. Arbuckle

In the State of North Carolina it is estimated that over five million eggs are hatched annually in incubators. Of this number, according to figures presented in this paper, over two million eggs with perfectly developed chicks in them are thrown away each year.

At the prevailing price of market eggs this winter this represents a loss of $80,000 in money. When we consider the time, the interference of business, and the high cost of breeding stock, a large per cent of which is brought about by artificial incubation, we are justified in placing the loss at double the figure given. This loss for the United States approaches the astounding figure of $3,000,000.

The author has been interested in poultry raising for over thirty years, and it was his unsatisfactory experience with incubators that led to this investigation, which covers a period of five years.

When it was discovered that the most serious loss in artificial incubation was due to death in the shell after the eighteenth day, provided the conditions generally believed to be essential to a good hatch be kept under proper control, the confines of the problem were greatly reduced.

The loss in artificial incubation was first attributed to unequal temperature. Incubation was conducted at temperatures ranging from one hundred degrees to one hundred and six degrees with slightly varying results in losses. Finally, the temperature factor was removed by using a mercury regulator, which kept the temperature within a quarter of a degree of the desired standard throughout the incubation period.

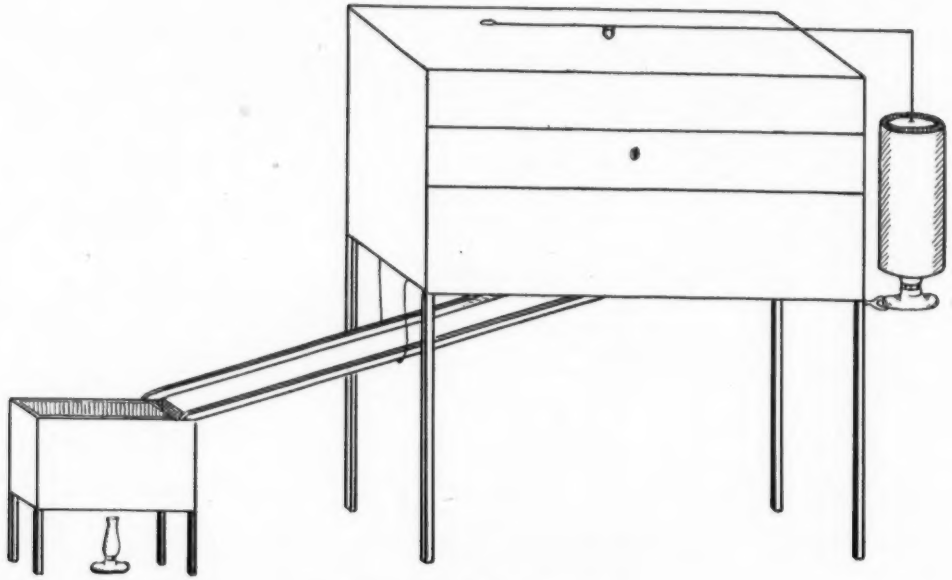
It was next thought to be due to abnormal evaporation on account of incorrect moisture. Experiments led to a very satisfactory determination of proper moisture. A hen was placed on a sitting of

eggs beside the incubator, which was started at the same time. Marked eggs were taken from the hen nest every day and weighed on a chemical balance. The same number of eggs from the incubator were weighed each day. The average loss in weight of fertile eggs from the hen nest at the close of the eighteenth day was found to be 11.4%. The average loss of weight of the fertile eggs taken from the incubator was 18.5%. By proper adjustment of moisture in this particular incubator it was possible to carry through hatches with loss of between 11 and 12%, which we presume must be correct. This adjustment of moisture improved the hatch, but did not cut down the loss in marked degree.

Turning and cooling the eggs were studied with similar results.

A personal experience of the author led to the present attempt to solve the problem. He was in the center of a large auditorium in Atlanta, not noted for good ventilation. The air which he was breathing was coming to him after being used by the great throng on the floor below. After suffering great discomfort he arose to leave the auditorium, and found himself so weak he was scarcely able to walk. The sense of relief experienced when fresh air was reached can never be forgotten. By fortunate coincidence, an incubator was hatching that night, and the author's mind reverted to those little chicks in the shell preparing for the supreme struggle of their lives, when they were by sheer strength to break their way into this world. Certainly if they were seized with the weakness just described they must fail in their struggle and die exhausted. The conditions in the incubator were so similar that on careful deliberation it was believed that lack of oxygen was the principal cause of death. Incorrect moisture might produce great discomfort and be a sufficient reason for good ventilation, but with this exactly right the lack of oxygen might well produce extreme weakness. Animals are supplied with a marvelous nerve mechanism controlled by centers in the brain which speed up or slow down respiration according to the demands of the body for oxygen, but any one who has on a mountain top experienced conditions

PLATE 9



EXPERIMENTAL INCUBATOR.

calling for rapid breathing knows that this wonderful mechanism cannot prevent weakness, which may be due chiefly to lack of needed oxygen.

This led to the investigation, the results of which are presented in this paper.

The author was so convinced of the correctness of his conclusion that he proceeded at once to remove the occasion for the shortage of oxygen, that is, the breathing chick. Before analyzing the air in incubators, he constructed and operated an incubator designed to remove the chicks as rapidly as they were hatched. This incubator is shown in the accompanying figure (Pl. 9).

A light in front of a glass window attracted the chicks toward the front of the egg drawer as soon as they were out of the shell. In their path was a hole cut in the floor of the egg drawer. Falling through this hole and landing on a trap door in the floor of the incubator, supported on delicately adjusted springs, they were emptied out into the chute and soon found themselves in the brooder, where they could breath all the oxygen they needed without robbing their brothers in the eggs above.

The results of these experiments are given in table I (experiments F and G), and show marked improvement over those for the same incubator under normal conditions. Unfortunately, this incubator had a mechanical defect, which was considered important enough to justify abandoning it. Before another was built it was thought more practicable to try the application of oxygen.

The results of the use of oxygen are reported in the table, experiments H, I, J, and K. The author has been handicapped by the limited number of experiments he is compelled to report, because incubators were not accessible, but he feels that the results certainly justify further experimentation.

The analyses of air given in table II point definitely to the fact that there is a shortage of oxygen, beginning early in the eighteenth day and reaching a point below fifteen per cent. Some physiologists believe that animal vigor and health will be rapidly impaired in an atmosphere of low oxygen content.

TABLE I—INCUBATION EXPERIMENTS

	Experiments	Egg Capacity	Eggs Given	Eggs Fertile	Chicks Hatched	Failed to Hatch				Per Cent of Chicks	Per Cent Dead in Shell
						Undeveloped	Deformed	Eggs Broken	Matured		
Normal incubator hatches four machines	A	120	100	92	40	6	6	.....	40	43.5	43.5
	B	120	120	101	52	5	3	.....	41	51.8	40.8
	C	150	150	140	66	9	5	.....	61	47.1	43.6
	D	60	60	55	22	9	3	.....	20	40.0	36.3
	E	240	235	202	115	7	2	2	76	56.9	37.6
Chicks removed	F	120	120	112	84	10	8	.....	10	75.2	9.0
	G	120	120	110	80	13	7	.....	10	72.7	6.4
Oxygen applied	H	240	210	190	123	53	8	.....	36	64.7	18.9
	I	240	230	190	129	7	16	.....	38	67.9	20.0
	J	240	220	192	162	.....	8	.....	22	84.4	15.6
	K	240	200	175	145	11	2	.....	17	82.9	9.8
8 hens	L	120	120	105	70	24	2	4	5	66.7	4.8

TABLE II—ANALYSES OF AIR

Experiment	Oxygen Given	Percentage of Oxygen				
		17th Day	18th Day	19th Day	20th Day	21st Day
D	None	20.8	20.1	18.2	17.4	16.5
E	None	.....	20.4	19.2	17.8	15.2
C	None	20.7	20.2	18.8	17.2	14.4
H	19th day	20.7	19.2	20.2	20.4	22.8
I	20th day	20.7	19.2	17.2	21.4	24.0
J	18th day	20.8	20.4	20.6	20.4	21.2
K	18th day	20.7	20.4	21.2	21.4	.....

By way of comparison with artificial incubation the results are reported in the case of eight hens, which probably show a record below normal, because one hen by leaving her nest caused a heavy loss, but the very low figures, 4.8%, for loss from death in shell after the eighteenth day, is significant, and probably presents a not unreasonable standard for an incubator operated under perfect conditions.

The tables are self-explanatory. Manifestly they present opportunities for numerous inaccuracies. For instance, it is evident that

all chicks failing to hatch because of some deformity due to abnormal conditions of development could not be certainly determined. Deformities in chicks developed under hens show that these irregularities are not confined to artificial incubation.

As to application, regulation, and cost of oxygen, it was found that oxygen was most conveniently handled in small cylinders, capacity forty gallons of gas. The gas was passed through water, and by counting the bubbles, computing the cubical contents of incubator, and analyzing the air it was found a simple thing to regulate the flow of gas so as to keep the air in the incubator close to normal. Note experiments J and K. The oxygen was introduced in the current of warm air entering the incubator. The quantity required in one case was forty gallons, which cost two dollars, but in another experiment, K, which gave good results, approximately thirty gallons were used. If we take forty per cent as an average figure of loss from death in shell after the eighteenth day, we would in experiment J have secured 107 chicks instead of 162. If the oxygen used was the cause of the 55 additional chicks getting out of the shell, we have a right to say that the two dollars spent for oxygen was a good investment, for this is less than three cents per chick. If they were high-bred stock they would be worth ten times this amount.

One of the interesting features of these experiments with the oxygen-fed incubators was the comfort of the chicks during the last days of the hatch; no crying, no panting, no running about. The absolute quiet was proof that the chicks were enjoying the oxygen.

There seems to be reasonable grounds for believing that lack of oxygen in incubators during the last two days of hatch has much to do with the heavy losses in artificial incubation. Certainly the results reported would justify further investigation by our experiment stations.

DAVIDSON COLLEGE, N. C.

BRIEF COMPARISON OF THE HERPETOLOGICAL FAUNAS OF NORTH CAROLINA AND VIRGINIA

By C. S. Brimley

The recent list of the Reptiles and Amphibians of Virginia published by Mr. E. R. Dunn (Copeia, Jan. 25, 1918) offers an opportunity for comparing the herpetological fauna of that State with the same fauna of North Carolina. The lists following are based on the above mentioned list with one addition (*Scaphiopus holbrooki*, see Copeia, No. 55), as compared with my list of North Carolina Reptiles and Amphibians (Elisha Mitchell Journal, March, 1915), as corrected to date.

SALAMANDERS.

a. Recorded from both States. Siren, Amphiuma, Hellbender, Marbled Salamander, Spotted Salamander, Tiger Salamander, Redbacked Salamander, Viscid Salamander, Red Triton, Carolina Red Triton, Striped Salamander, Holbrook's Triton, *Desmognathus fusca*, *D. quadramaculata*, *D. monticola*, American Newt.

b. Recorded from Virginia only. *Hemidactylium scutatum*, *Plethodon aeneus*, *Gyrinophilus porophyriticus*, *Spelerpes longicauda*, *Ambystoma jeffersonianum*.

c. Recorded from North Carolina only. Water Dog, Southern Water Dog, Mole Salamander, Dwarf Salamander, Schenck's Red Triton, Daniels' Triton, *Stereochilus marginatus*, Metcalf Salamander, Sherman Salamander, Yanahlossee Salamander, *Leurognathus marmoratus*, *Desmognathus o. carolinensis*, *Des. fusca auriculata*.

FROGS AND TOADS.

a. Recorded from both States. Common Toad, Fowler's Toad, Solitary Spadefoot, Chorus Frog, Cricket Frog, Common Tree Frog, Peeper, *Hyla squirella*, Bullfrog, Spring Frog, Leopard Frog, Pickerel Frog, Wood Frog, *Rana virgatipes*, Narrow-mouthed Toad.

b. Recorded from Virginia only. *Hyla cinera evitta*.

c. Recorded from North Carolina only. *Hyla cinerea*, *Hyla femoralis*, Dwarf Toad.

LIZARDS.

a. Recorded from both States. Glass Snake, Fence Lizard, Sand Lizard, Ground Lizard, Bluetailed Lizard.

b. Recorded from North Carolina only. Green Lizard.

SNAKES.

a. Recorded from both States. Banded Rattlesnake, Copperhead, Cottonmouth, Water Snake, Willow Snake, Garter Snake, Ribbon Snake, DeKay's

Snake, Redbellied Snake, *Haldea striatula*, *Virginia valeriae*, Worm Snake, Rainbow Snake, Horn Snake, Southern Green Snake, Ring-necked Snake, Black Snake, Black Chicken Snake, Spotted Racer, Black King Snake, Brown King Snake, Milk Snake, Red King Snake, Pine Snake, Spreading Adder.

b. Recorded from Virginia only. Northern Green Snake.

c. Recorded from North Carolina only. Diamond Rattlesnake, Ground Rattlesnake, Coral Snake, Crowned Tantilla, Coachwhip, Striped Chicken Snake, *Rhadinaea flavilata*, Hognosed Snake, *Cemophora coccinea*, *Natrix taxispilota*.

CROCODILES.

a. Recorded from North Carolina only. Alligator.

TURTLES.

a. Recorded from both States. Loggerhead Sea Turtle, Box Turtle, Painted Turtle, Speckled Turtle, Redbellied Terrapin, River Terrapin, Diamondback Terrapin, Musk Turtle, Mud Turtle, Snapping Turtle.

b. Recorded from Virginia only. Geographic Terrapin, LeSueur's Terrapin.

c. Recorded from North Carolina only. Leatherback Sea Turtle, Green Sea Turtle, Kemp's Loggerhead, Yellowbellied Terrapin, Florida Terrapin, Troost's Terrapin, *Clemmys nuchalis*.

SUMMARY

	From both.	*From Va. only.*	*From N. C. only.*
Salamanders	16	5	13
Frogs and toads	15	1	3
Lizards	5	0	1
Snakes	25	1	10
Crocodilians	0	0	1
Turtles	10	2	7
Totals	71	9	35

Of the forms recorded from North Carolina and not from Virginia, seven salamanders and one turtle are forms confined to the mountains, five salamanders, three turtles, and all the additional frogs, lizards, and snakes, as well the one crocodilian, are southern species mainly entering our State from the southeast, the others being three sea turtles and one salamander (water dog) of wide distribution. On the other hand, the forms occurring in Virginia and so far not known within this State are with one exception (*Hyla cinera evitta*) forms of more northern distribution.

RALEIGH, N. C.

ELIMINATIONS FROM AND ADDITIONS TO THE NORTH CAROLINA LIST OF REPTILES AND AMPHIBIANS

By C. S. Brimley

ELIMINATIONS

1. *Ambystoma jeffersonianum.* Our only record is from Roan Mountain, where S. N. Rhoads collected a number in 1894, but Dunn (Proc. Acad. Nat. Sc., Phila., Jan., 1917, p. 23) states that Rhoads' specimens were not this species, but *Plethodon metcalfi.*

2. *Desmognathus nigra.* According to Dunn (Proc. USNM, Vol. 53, p. 401), the species which has been going under this name is *D. quadramaculata,* while of Rhoads' two specimens from Roan Mountain, one was this latter species and the other *Leurognathus marmoratus.*

3. *Desmognathus ochrophea.* According to Dunn (Proc. USNM, 1c, p. 417 *et seq.*), our mountain salamanders of the *ochrophaea* group are not the northern form *ochrophaea,* but a distinct subspecies which he names *D. o. carolinensis.*

4. *Gyrinophilus porphyriticus.* Our only record of adults is from Roan Mountain (Rhoads), but Dunn (Proc. Acad. Nat. Sc., Phila., Jan., 1917, p. 19), who looked over the collections of the Philadelphia Academy of Natural Sciences, where Rhoads' specimens were deposited, records *Gyrinophilus danielsi* from Roan Mountain, but not this form, hence we must discard Rhoads' record, which leaves only the larval record from Black Mountain, which is at least open to doubt as to the correct identification of the specimens.

5. *Chelopus muhlenbergi.* The specimens from Statesville in the National Museum recorded by Yarrow, but now lost, are probably referable to Dunn's new species, *Clemmys nuchalis,* of which he collected specimens at Brevard and Linville.

6. *Deirochelys reticulatus.* Probably not North Carolinian, and therefore dropped till we get positive evidence of its occurrence.

7. *Pseudemys mobilensis.* The specimen from White Lake, referred by me to this species, is probably better referable to *concinna.* I doubt if the two are distinct, anyway.

ADDITIONS

1. *Desmognathus monticola* Dunn (Proc. Biol. Soc. Wash., Vol. 29, p. 73). Described from Brevard, and is what we have been considering the pale form of *D. quadramaculata,* having practically the same distribution in the State.

2. *Desmognathus ochrophaea carolinensis* Dunn. The specimens from the North Carolina mountains referred to *D. ochrophaea* all belong here (see Dunn, Proc. Biol. Soc. Wash., Vol. 29, p. 74).

3. *Desmognathus fusca auriculata Holbrook.* Dunn (Proc. USNM, Vol. 53, p. 413) refers specimens from Wilmington, Beaufort, and Lake Waccamaw here, while I have taken at least one at Raleigh.

4. *Plethodon yonahlossee* Dunn. Described from near Linville (Bull Am. Mus. Nat. Hist., Vol. 37, p. 598 *et seq.*).

5. *Spelerpes montanus* Baird. The common red *Spelerpes* at Raleigh, and apparently in most of the State east of the mountains. Dunn, in a letter of date January 4, 1917, refers to this, specimens from Raleigh, Morganton, Salem, Hillsboro, Beaufort, and Summerville, leaving Raleigh and Goldsboro as the only eastern localities for *ruber.* See Brimley, Proc. Biol. Soc. Wash., 1917, p. 87, and Dunn, Bull. Am. Mus. Nat. Hist., Vol. 37, p. 614.

6. *Clemmys nuchalis* Dunn. Described from Linville; specimens also taken at Brevard. E. R. Dunn, Bull. Am. Nat. Hist., Vol. 37, p. 624.)

RALEIGH, N. C.

A VISIT TO SMITH ISLAND

By W. C. Coker

Smith Island is often referred to but rarely visited by North Carolinians. As a far-flung outpost of subtropical vegetation it is, perhaps, the most unique botannical possession of a State that can exhibit within its borders a range of plant life that would seem quite at home in Florida on the one hand and in Labrador on the other.

The island is not easily accessible and has been visited by few botanists. In Timber Trees and Forests of North Carolina (Bull. No. 6, N. C. Geol. Survey. 1897), by Pinchot and Ashe, there is a fine photograph of palmettos from the island. Mr. Ashe informs me that this photo was made by him and that he knows of no other botanist having visited Smith Island.

On April 5th last I and two of my students, Mr. Couch and Mr. Vogler, went over to the island in a launch from Southport and spent most of the day. We knew, of course, that there were true palmettos there, but were greatly surprised at their vast numbers and large average size. They were everywhere, and as the island is large their numbers must run easily into the fives or tens of thousands. As they stand naturally scattered in the thick forest growth their number does not impress one so forcibly, but in the cleared strips that extend across the island at regular intervals and in which the owner has had the good judgment to leave the palmettoes, they stand in impressive groves, unhidden by other vegetation, and reminding one of the best groves of the Florida coast (Pls. 10, 11, 12). Many of the trees were twenty to twenty-five feet high, and not a few were thirty feet. Unfortunately, many of the palms had been killed and many others injured by the coldest winter in about forty years. About half(?), however, have withstood the shock.

The herbaceous flora was hardly beginning its growth, as the spring had been a cold one, and we found little or nothing in flower among such plants except a few weeds. Besides two ferns (southern polypody, which was common, and ebony spleenwort, which was rare) our records were confined almost entirely to woody plants. An interesting exception was the discovery of the sub-tropical cactus *Opuntia*

PLATE 10

SABAL PALMETTO.
Smith Island, N. C.

Photo by W. C. C.

PLATE 11

SABAL PALMETTO.
Smith Island, N. C.

Photo by W. C. C.

SAND DUNES.
Smith Island, N. C.

Photo by W. C. C.

PLATE 13

OPUNTIA DRUMMONDII.
Smith Island, N. C.

Photo by W. C. C.

PLATE 14

OPUNTIA DRUMMONDII.
Smith Island, N. C.

Photo by W. C. C.

Drummondii Graham (*O. Pes-Corvi* Le Conte). This species was described from Florida and is given in Small's Botany of the Southern United States as occurring on the coast of Florida and Georgia. It was found by me on the Isle of Palms, S. C., and recorded in my account of the flora of that island (Torrya **5**: 143. 1905). The first, apparently, and, so far as I know, the only* North Carolina record is by Kearney from Ocracoke Island (Contr. U. S. Nat. Herb. **5**: No. 5, pp. 270, 313, 317. 1900).

Of particular interest is the variation in the appearance of this plant when growing under different conditions. It is described as having small, nearly cylindrical joints, and this form we found here, and also on the previous day in exposed sand at Wrightsville. But when growing in rich black sandy loam, protected from the high winds and drifting sand, it may assume a very different appearance, as shown in our plates 13 and 14. The plants shown were in a recent small clearing well back from the shore, and in this rich spot the joints were broad and flat and many times larger than usual. Smaller ones approaching the shore forms were also found in the immediate neighborhood of the large ones, and all intermediate sizes also appeared. As mentioned by Dr. Small, the joints separate very easily from one another and they attach themselves with exasperating readiness and firmness to one's clothing, or anatomy. This Opuntia, called "dildoes" by the negroes of the South Carolina sea-islands, is easily distinguished from the much more common and more widely distributed *Opuntia Opuntia* by the several long slender spines to each areola, the smaller fruit, and usually much smaller and cylindrical joints.

Among the woody plants the most interesting to us were the subtropical evergreen magnolia (*Magnolia grandiflora*) and the mock orange or Carolina laurel-cherry (*Laurocerasus carolinianus*), both of which were scarce and seem to reach here their northern limits in the natural state. They are both highly prized ornamental trees in cultivation throughout the South Atlantic and Gulf States.

*Except in the Journal of the New York Botanical Garden **19**: 71. 1918, where Dr. Small says that Dr. R. M. Harper told him "of an observation he made on one of the sea-islands of North Carolina, where a number of joints of this small but viciously armed prickly-pear had become firmly attached to the lips of a cow while it was grazing." Dr. Small also refers to this Opuntia in two other articles in the same journal, **18**: 237. 1917, and **19**: 1. 1918.

The American olive (*Olea americana*), another fine evergreen tree, was very abundant, and on many were still hanging the ripe, purplish fruits which are very like small olives. Though very fine it is rarely seen in cultivation.

The island is covered thickly, except for the dunes, with arborescent growth of low to medium height. Constituting this growth in the western section, which was the only part examined by us, were the following species of woody plants:

TREES

Loblolly or Old Field Pine (*Pinus Taeda* L.), plentiful in places.
Red Cedar (*Juniperus virginiana* L.), plentiful.
Palmetto (*Sabel Palmetto* (Walt.) R. & S.), abundant.
Live Oak (*Quercus virginiana* Mill.), abundant.
Laurel Oak (*Quercus laurifolia* Michx.), abundant.
American or Wild Olive (*Osmanthus americanus* (L.) B. & H.), abundant.
Yopon (*Ilex vomitoria* Ait.), very abundant.
American Holly (*Ilex opaca* Ait.), rare.
Toothache Tree or Prickly Ash (*Xanthoxylum Clava-Herculis* L.), plentiful.
Smooth Red Bay (*Persea borbonica* (L.) Spreng), abundant.
Flowering Dogwood (*Cornus florida* L.), plentiful.
Red Mulberry (*Morus rubra* L.), not rare.
Hercules Club or Angelica Tree (*Aralia spinosa* L.), plentiful.
Carolina Laurel Cherry (*Laurocerasus carolinianus* (Mill.) Roem.), rare.
Magnolia or Bull Bay (*Magnolia grandiflora* L.), rare.

SHRUBS

St. John's Wort (*Ascyrum hypericoides* L.), plentiful.
French Mulberry (*Callicarpa americana* L.), not rare.
Wax Myrtle (*Myrica cerifera* L.), very abundant.
Groundsell Tree (*Baccharis halimifolia* L.), abundant.
High Bush Huckleberry (*Vaccinium corymbosum* L.), plentiful.
Tall Blackberry (*Rubus nigrabaccus* Bailey?), plentiful.
Dwarf Sumach (*Rhus copallina* L.), plentiful.

VINES

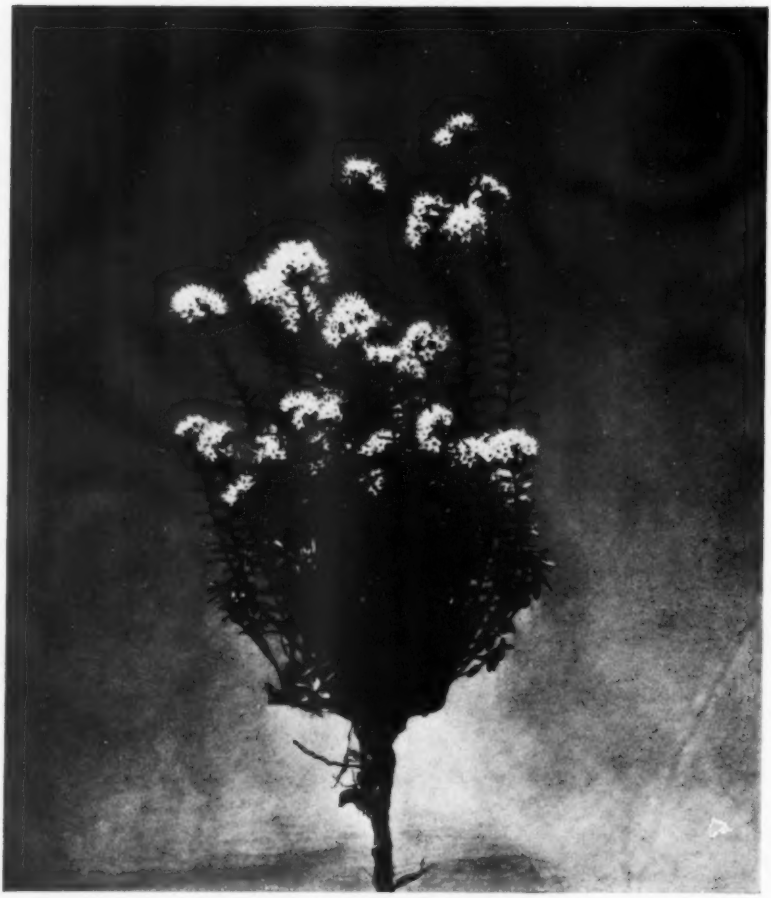
Several species of Smilax (undetermined).
Trumpet Honeysuckle (*Lonicera sempervirens* L.), rare.
Muscadine or Bullace (*Vitis rotundifolia* Michx.), rare.
Virginian Creeper or American Ivy or Woodbine (*Ampelopsis quinquefolia* Michx.), plentiful.
Yellow Jessamine (*Gelsemium sempervirens* Ait.), rare.
Supple-Jack (*Berchemia scandens* Neck.), abundant.
Poison Ivy or Poison Oak (*Rhus toxicodendron* L.), abundant.

PLATE 15

DENDRIUM BUXIFOLIUM.
Brunswick County, N. C.

Photo by W. C. C.

PLATE 16



DENDRIUM BUXIFOLIUM (reduced). *Photo by W. C. C.*
Brunswick County, N. C.

The larger fungi were hardly appearing as yet, but *Favolus arcularius* was abundant on wood, and in the pure sand of an exposed dune we found a good plant of the mushroom *Volvaria speciosa.* As was to be expected, the *Volvaria* differed from the inland form in some respects, particularly in the larger spores. Although we found no species of the apple group, a few typical galls of the apple-cedar rust (*Gymnosporangium macropus*) were found on the cedar. The spores were probably blown from the mainland several miles away.

I shall not refer here at any length to our observations on the flora of the mainland during this trip, but must include photographs of the very interesting and beautiful little shrub, *Dendrium buxifolium,* which is closely related to the heathers of Europe. This little plant is very local in its distribution and is one of three species of the eastern United States, one of the other two occurring only on the tops of the highest mountains of North Carolina and Tennessee, the other, a species recently (1901) recognized by Dr. Small, is from Table Mountains and a few similar heights in North Carolina and South Carolina. The coastal plant has been reported from the coastal plain of New Jersey to Florida, but seems to have been rarely collected south of New Jersey, as Dr. Small, who has recently monographed the *Ericaceae,* says (N. Am. Flora **29**: 39. 1914) that he has seen no specimens from south of New Jersey.* Along the railroad and the highway from Wilmington to Southport the *Dendrium* is very abundant and grows in close-set colonies over large areas, sometimes as much as an acre in extent. In Plate 15 is shown such a colony in full bloom, and in Plate 16 a single plant. The soil where it grows is sandy and poor and intermediate in elevation and water content between the lower flats (where grow *Azalea atlantica*† and Venus' fly-trap) and the more dry and elevated areas.

While on Smith Island as well as on the return trip to Wilmington by earth road we secured living specimens of many shrubs and a few vines and trees for planting in the University Arboretum.

Chapel Hill, N. C.

*We also have good specimens from Springville, Darlington County, South Carolina.

†An illustrated account of this newly described species will be given in a future number of this Journal.

REVIEW

Professor E. W. Gudger has recently published *A Primer of Household Biology** of decided merit. The book has been reviewed by Dr. James J. Wolfe, of Trinity College—this review having appeared in a folder from the State Normal College. To give this review a wider circulation I take pleasure in reprinting it below. I can heartily recommend the book for use as a text in biology in high schools, and believe it is particularly suitable for girls as a preparation for more intelligent conduct of the home. As indicating still further the cordial reception Dr. Gudger's *Primer* has received, I quote from a letter to Dr. Gudger from Dr. W. T. Sedgwick, of the Massachusetts Institute of Technology, who is a biologist of the highest reputation.

W. C. C.

Dr. Sedgwick says:

"At last I have got around to looking over rather carefully your *Primer of Household Biology*, upon the appearance of which I hasten to congratulate you.

"You have undoubtedly done a good thing—in the first place in drawing attention to the subject and the need of household biology. We have long had household economics, household sanitation, and household bacteriology, and it was high time that we had a household biology.

"Your choice of forms and your treatment in each case seems to me thoroughly scientific and yet practical, and you have made the book a real Biology."

The review by Dr. Wolfe follows:

"A book now issued as a bulletin and modestly styled primer by its author, represents a new departure in the teaching of Biology in this country. Here for the first time so far as the writer knows, have the facts of this science with a bearing on household efficiency been marshaled with a view to welding them into an organized body of knowledge. Twelve years spent in teaching this subject to young women has peculiarly well fitted Dr. Gudger to choose wisely the materials best adapted to this purpose.

"The laboratory work embraces the study of only five types of living things, viz., a green alga, yeast, amoeba, bacteria, and molds. The

*A Primer of Household Biology by E. W. Gudger, Ph.D. Bull. N. C. State Norm. and Ind. Col., Vol. 7, No. 1, pp. 3-103, Sept. 1917. For sale by the College, price 55 cents.

study of types is thus reduced to its lowest terms. Nevertheless, so skillfully and thoroughly are the details derived from these several sources interwoven and tied together that aside from problems of evolution and classification most of the great principles of Biology are well presented. For example, upon the study of a simple, single-celled plant, including experimentation and microscopic examination, is based the fundamental biological concept that in the last analysis the world's supply is dependent absolutely and completely upon the green material of plants. Likewise a single simple animal is used to establish the equally important generality that animals are primarily transformers and liberators of the energy stored by green plants. The limits of this review would hardly permit an epitome of the treatment devoted severally to the yeasts, bacteria, and molds. Suffice it to say that they are handled adequately, clearly, and forcefully, both as to their beneficial and their baneful activities. No person, especially a woman, who puts into practice the information contained in this book can fail to live a healthier, happier, and more efficient life herself, and to contribute immeasurably to the well-being of those dependent upon her ability to make a well-ordered home.

"It is difficult better to express briefly the contribution of the book than to quote its purpose as stated by the author—'to do two things for the students who use it: to give them a sound scientific conception of some of the great fundamental principles of Biology and to drive home to them such a practical knowledge of certain most important living things as will enable them to live healthier and happier lives,' and then to say that in the judgment of the reviewer, and in the slang of the day, he has made good.

"It is a real pleasure to chronicle the appearance of a practical book of such excellence from a neighbor institution, and to say that, in the opinion of the writer, the inclusion of a course in Biology such as is here worked out would contribute strength and depth to any serious study of domestic economy."